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Journal
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Original Communications.

WITH A FIELD AMBULANCE ON TRAINING AND MANŒUVRE EXERCISES IN INDIA.

By Lieutenant-Colonel T. S. DUDDING, O.B.E.
Royal Army Medical Corps.

The material for this article was obtained from happenings in the Northern Command in India, in November and December, 1925, when large-scale manœuvres took place over the country to the south and east of the River Indus in the vicinity of Attock. The troops for one force engaged were drawn chiefly from the Peshawar district, and for the other from the Rawalpindi district, with cavalry and certain other troops from further afield. The former, or Blue Force, was preponderant in cavalry, whilst in the latter, or Khaki Force, infantry was stronger. A further difference between the opposing forces was the equipping of the Khaki Force with wheeled transport only, animal-drawn for units and divisional train, and mechanical for the supply column; and what is of more immediate interest the field ambulances were provided with four motor ambulances each. It is with the field ambulances of the latter force that these notes are concerned, and more especially with the 12th Indian Infantry Brigade Field Ambulance.

As it is not proposed to describe the manœuvres from the combatant point of view, only the movements that may be required to illustrate the particular incidents in connexion with the working of a field ambulance will be considered.

Manœuvres were preceded by two to three weeks' independent brigade

training in appointed areas, and on the date of the commencement of manœuvres the situation developed with the advance of the different brigades from these scattered areas as their starting points. Excellent maps of the training and manœuvre areas were supplied. These were marked with the new degree-minute grid which is being adopted in India. Two sample sketch maps showing (*a*) brigade training area, and (*b*) manœuvre area, are given to enable readers better to appreciate the exercises and situations that occurred.

The three Field Ambulances, 13th, 11th and 12th, serving the division of the Khaki Force with which we are concerned, mobilized at the Medical Mobilization Stores at Rawalpindi on November 5 and 7, and marched to their respective brigade training areas on November 9, 11 and 14. The personnel were brought in from all over the Northern Command, including the frontier, and consequently they were a somewhat heterogeneous mixture, only a few of them having any previous experience of field ambulance work. Experienced and responsible superior personnel were markedly deficient, e.g., only one assistant surgeon instead of four; storekeepers of inferior rank and experience, and considerable shortage in nearly all other classes of personnel rendered the initial task of getting the units together by no means easy; but it is what might happen at first on a real mobilization, though doubtless the more experienced men who remained at the hospitals which had to be kept going would join up. It could not be expected that officers commanding hospitals would send out their best men on peace-time manœuvres when they themselves needed them to run their own hospitals. The drawing of equipment had been facilitated, as practically everything except transport had been drawn beforehand by D.A.D.M.S. mobilization.

For the benefit of those who have had no experience of an Indian field ambulance, it is well at this stage to state that this unit, as at present constituted, is divided into four sections, "A," "B," "C," and "D," each equipped to deal with twenty-five patients, or 100 in all. "A" section is the headquarters and British troops section, the other three being for Indian troops (the Indian Infantry Brigade consists of one British regiment and three Indian regiments). The British personnel consists of 5 officers, 4 assistant surgeons, 1 serjeant, and 4 B.O.R.'s, R.A.M.C., total 14. The Indian personnel consists of four sub-assistant surgeons with clerks, storekeepers, ambulance and nursing orderlies, ward-servants and other followers, making up a total of 235 exclusive of transport and sick transport personnel. The stretcher-carrying capacity is twenty, plus an additional twelve squads for "savage warfare." The sick transport consists of twelve riding ponies and twelve bullock tongas; the latter were replaced for part of the time on these exercises by four motor ambulances (actually both bullock tongas and motor ambulances were taken along). The equipment and tentage are carried on pack mules and in army transport carts on normal scale transport, but the carts are replaced by camels when the alternative scale is ordered for operations in roadless and hilly country.

The system of furnishing transport differs in Indian and British field ambulances. In the latter the transport is attached to the unit and remains with it as part of the unit, whereas in the former it returns to its own transport unit with personnel, animals and vehicles complete at the end of each day's march, and rejoins the field ambulance on the following morning before the march.

Such then is a brief description of the Indian Field Ambulance as at present constituted. The 11th and 13th Field Ambulances were thus composed, but the 12th Field Ambulance was different. This unit was built up on the lines of a British field ambulance, i.e., it consisted of a headquarters and two companies. Its accommodation and carrying capacity were the same as those of the old Indian Field Ambulance, and its personnel was approximately the same in numbers and composition, but considerable changes in the equipment and its distribution were introduced. The "headquarters" comprises the hospital proper and all the tents form the basis of the main dressing station, whereas the two companies consist of the advanced dressing station and bearer portions of the unit. But each of the three portions is complete in itself (except for tents) and can function independently, dealing with the needs of both British and Indian patients This was the unit's first appearance, an experimental "try out" with improvised equipment; the results and conclusions drawn from them are still under consideration by Army Headquarters, India. It was while working with this unit that these notes on field work were compiled.

Brigade Training Exercises.

The 12th Indian Infantry Brigade Group was encamped at Usman Khattar on the south bank of the River Haro, which in the non-rainy season consists of a broad stony bed 300 to 400 yards in width, along which run snake fashion two fordable streams, 20 to 40 yards wide. Such streams as these occur frequently in frontier country, now narrowing to form gorges between high hills which rise steeply on either side, and now widening out and forming a fertile cultivation "kach" or flat on one bank or in mid-stream. Along this stony bed the line of advance may have to move, necessitating "complete pack" transport. It is only afterwards that a road may be made, a road usually difficult of construction but invaluable for opening up the country.

From this camp the brigade marched out each day to a definite starting point with a definite task to undertake and returned in the evening. The field ambulance was opened up in the camp, and was regarded in some of the exercises as the main dressing station to which wounded would be evacuated.

Exercise I.—Extract from 12th Indian Infantry Brigade Operation Order, No. 3.

"The 12th Infantry Brigade Group will destroy Mumrhal to-morrow morning, proceeding via Garhi Saiyidan and north of range of hills running

east and west along right bank of River Haro. 12th Field Ambulance will open an A.D.S. at Garhi Saiyidan and establish bearer relay posts on the north bank of the river and Brown House as the situation permits."

A reference to the map showed Mumrhal to be a village on a hill about half a mile to the north of the river and about four miles in direct line from camp. The country towards it was flat, but consisted of fields gridded with irrigation streams, and without roads except a track made by the sappers and miners as far as Usman Khattar, a village three-quarters of a mile away on the line of advance. This ground proved to be a serious stumbling-block for a unit with practically only wheeled ambulance transport.

Orders were, therefore, issued for "A" Company (less wheeled transport) to accompany the column, taking with it two ambulance bullock tongas and Mackormick wheeled stretchers. (Motor ambulances were not at this time available and would of course have been useless.) It was considered that the bullock tongas could be used from Usman Khattar to the M.D.S., and the wheeled stretchers from the A.D.S. at Garhi Saiyidan to the tongas. Nine stretcher squads were available. The total equipment that could be taken consisted of one pair of field medical panniers and one pair of water pakhals carried on two mules, together with medical companion, surgical haversacks and directing flags, and stretchers carried by the bearers. Riding ponies for lightly wounded cases were not available.

Now what actually happened? The two tongas returned after proceeding about one-third of a mile, being unable to get on any further. The wheeled stretchers were taken along with the utmost difficulty, having to be lifted across the irrigation channels in places and pushed through or round soft irrigated areas; but still they got to the A.D.S. and back again. On trying to follow the track a little later the O.C. lost it, and found himself wallowing with his horse in the maze of irrigation channels and soft land, and wondering how to evacuate his casualties over such ground. The A.D.S. was established at Garhi Saiyidan, troops crossed the river and advanced to the attack. As the objective was one and a half to two miles from the A.D.S., the establishment of numerous relay bearer posts was necessary; these were placed (in skeleton form), (1) between the A.D.S. and the river bank, (2) on the bank on the south side of the river, and (3) on the north side with digits following each of the two attacking units.

Fortunately no actual casualties did occur, and the Brigade Commander had been asked not to make any practice casualties owing to the lack of training of the unit. But had there been a number of casualties how would they have been evacuated? Obviously the number of bearers sent out was totally inadequate without the assistance of wheeled transport. At least half of the bearers of "B" Company would have had to be pushed up in front of the A.D.S. to strengthen the bearer relay posts between the A.D.S. and fighting line, leaving four squads to carry from A.D.S. to M.D.S. (three

miles), an impossible task without assistance. The lesson learnt was that for roadless country pack transport for equipment and wounded is necessary, mules and camels for the former, and riding ponies, camels fitted with kajawahs, and extra bearers for the latter. Some of us knew this, but the majority were out to learn.

Exercise II.—Extract from Operation Order, No. 6.

"The 12th Infantry Brigade Group will attack Bhui and ridge to north thereof and drive enemy across the River Haro. The attack will be carried out by the 2nd Foresters on the right and the 3/9 Jat Regiment on the left. Dividing line between battalions—8th M.S. nullah running due west thereof north edge of Bhui.

"The 5/7 Rajputs and 1/19 Hybad Regiments will follow in support, on receipt of orders to advance they will leap-frog through the forward battalions and take up a position forming a bridge-head on the left bank of the River Haro. The 12th Field Ambulance will open an A.D.S. 200 yards east of the Brigade Headquarters and establish bearer relay posts along the nullah running east from Bhui as the situation permits. The main artery will run along the dividing line between battalions.

"Reports to Brigade Headquarters at:—

(1) Mound 400 yards north-east of M.S. 8.

(2) Railway bridge over Hatar-Bhui nullah.

(3) Western end of Bhui ridge."

In this exercise the Infantry Brigade was considered to be acting as the advance guard of the main body which was advancing on Hassan Abdul from the east via Khanpur and Hatar along the main road. Bhui was on the direct cross-country line between milestone 8 and Hassan Abdul, and distant from it about ten miles; the direct route was about six or seven miles shorter than that by road. The brigade had left the main road east of Hatar and had advanced across country to the starting point near milestone 8. Its wheeled transport was directed to come round by the main road which passed milestone 8 and crossed the starting point and line of advance at right angles.

There was with the brigade, therefore, only "A" and "B" Companies (less wheeled transport) of 12th Field Ambulance. The headquarters with the wheeled transport formed a M.D.S. at Hatar village on the main road, three-quarters of a mile from (and before reaching) milestone 8, close to which the first A.D.S. was established.

Bhui village, the point of attack, was situated some two and a half miles away from milestone 8, across flat, open, treeless and roadless cultivated ground.

The exercise, from the medical point of view, gave opportunity for the establishing of (1) A.D.S.'s at three points along the main artery or central dividing line which was very definitely laid down; this brought in the system of leap-frogging; (2) bearer relay posts over a very long carry;

(3) car-loading post at a point on the road between the second A.D.S. and the M.D.S. The sites of the A.D.S.'s were in the bed of a winding nullah running from the first A.D.S. close up to the Bhui ridge, and the line of evacuation was up this nullah, thus bringing out the lesson of taking cover. Bearer relay posts of two squads each were established at intervals of 500 or 600 yards. It will be seen that in a long carry such as this nearly all the bearer squads were taken up in forming relay posts. One bearer squad had been sent to the M.O. of each regiment before the start to bring back the first casualty and to maintain touch between the R.A.P. and the officer in command of the bearer squads of the field ambulance, who as he advanced dropped his bearer relay posts. As he had now only fourteen squads at his disposal, he had just enough to form six relay posts, which brought him close to the Bhui ridge where the main attack commenced. A saving was brought about when the second A.D.S. was established by making an A.T. cart (in lieu of horsed ambulance) and two wheeled stretchers do the work of two stages. Wheeled communication had by now been opened up with the M.D.S., and a track had been discovered over the open by means of which it would be possible to get wheeled transport close up to Bhui to the third A.D.S. when the objective had been attained.

A few practice casualties were ordered to fall out, and these were carried back by the bearers. One such lying case was timed, and it was found that he arrived at the road car-loading post through the various relays in about one hour, by shoulder carriage by four relays of bearers for two miles and by wheeled stretcher for half a mile, which was quite good going.

As is usual in manœuvres, the advance was much more rapid than would have been the case in actual warfare, and with the few stretcher squads available for such a long carry, some of the casualties grew tired of waiting to be picked up and rejoined their units in the advance, a practice not usually indulged in when the bullets are flying round. The A.D.S.'s, in view of the rapid advance, were of the simplest type.

This exercise again brought out the necessity for additional bearer squads and riding ponies when operating away from roads, and it also showed the value of the main artery when it is possible to maintain it, walking casualties readily finding their way down it towards medical aid.

This exercise (as also No. 1) was carried out twice on consecutive days, attacking and supporting troops exchanging places. In the field ambulance on the first day the bearers' officer failed to follow the attacking troops through the supporting troops until the latter advanced. The result was that casualties occurring during the early stages of the attack were late in being cleared, and the stretcher squads attached to the unit M.O.'s had long carries before they established touch with the bearer officer, who delayed the advance of his bearers under the misapprehension that they must remain behind all the troops participating in the action. This mistake was profited by on the second rehearsal, with the result that

continued touch was maintained with three of the battalions, the fourth M.O., for some reason or other, sending back his stretcher squad as not required, possibly because the arrangements did not include his battalion amongst those dropping practice casualties.

Exercise III.—Extract from Operation Order, No. 9.

"The main body of the enemy was observed at mid-day to be going into camp at Hassan Abdul. Our main body reached an area two miles south-west of Khanpur. The 12th Infantry Brigade will find outposts from 14.00 hours to-day on the general line River Haro (inclusive), Godho-Dhamrah nullah. Battalion sectors are allotted as under . . . X battalion will be in reserve at old C.G. It is intended to stop the enemy *in front of* the line Bhui-Godho-Dhamrah. 12th Field Ambulance will establish an A.D.S. at road crossing over railway, just south of U in Usman Khattar. Packs will be worn, but C.O.'s will use their discretion as to the number of men allowed to remove boots and equipment. No smoking or fires will be permitted between 18.00 hours to-day and 07.00 hours to-morrow. Evening meals will be prepared in cooking places allotted by the staff captain and sent up after dark under unit arrangements."

This exercise was a defensive outpost scheme on a large scale, the frontage occupying about three and a half miles. Before the start one stretcher squad from the field ambulance was attached to the M.O. of each unit, who sent two of the bearers back to the field ambulance as soon as his R.A.P. was established, to indicate its exact position on the map. One bearer was retained by the field ambulance, which thus had messengers who knew the way to each R.A.P., and the second bearer was sent back to his R.A.P., fairly sure lines of communication for use during the night being thus established.

Unfortunately the O.C. the field ambulance did not read his map and trusted to his memory for finding the cross roads. He opened his A.D.S. at a railway cross road, but not the right one, and did not discover his mistake till after dark. He rectified matters by finding the proper spot, which was with difficulty recognized as a cross road, and by establishing a relay post there, and by notifying Brigade Headquarters of the change. No casualties were brought in, but the exercise showed the necessity for making sure of establishing good communications (if possible by daylight) for night operations over unknown ground; and in addition it was a test of discipline as regards lights, smoking and fires, under conditions of bivouacking on cold, frosty nights. No information is given in the orders as to the position of the M.D.S., but it must either be considered to have remained at Hatar, four and a half miles away, as in Exercise III, if L. of C. is guarded, or, what is more likely since the brigade is acting like an independent column, to have come up to the brigade, and that the A.D.S. has been formed by the whole field ambulance.

Exercise IV.

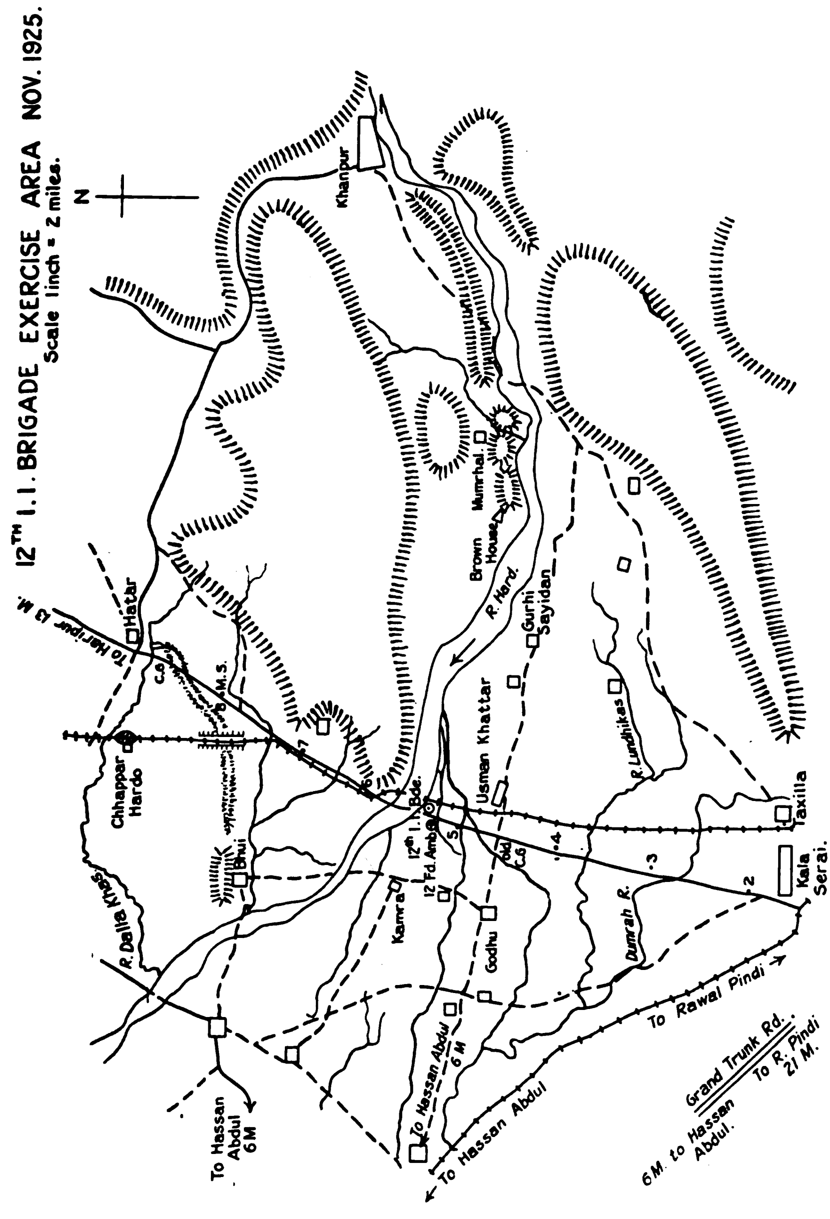
On this day units were responsible for arranging their own training. The following order was therefore issued :—

"No. 12 Field Ambulance will parade at 08.45 hours to-morrow, November 23, as strong as possible and march to the Usman-Khattar-Godho cross roads, where they will practise the formation of a M.D.S. and two A.D.S.'s."

This order was carried out; the M.D.S., being beside the main road, allowed of backward evacuation on the L. of C. by motor, but the A.D.S.'s were sited along a track (which was only passable by animal-drawn transport) at distances of 300 and 400 yards from the M.D.S. Attention was chiefly centred upon : (1) The proper laying out of each dressing station, with improvisation of shelters at the A.D.S., since only two eighty pound single fly tents were allowed to be taken by each A.D.S.; (2) the division of the dressing station into areas and the establishing of a systematic method of dealing with the patients, viz., reception, ticketing and recording of casualties, separation of the slight and serious cases, dressing of wounds, removal to waiting area, and controlling of evacuation; (3) cooking arrangements for three or four classes of individuals, viz., British, Mohammedans, Hindus and Gurkhas; (4) arrangements for water supply, latrines, pack store, mortuary, etc. When the bearers have gone out the remaining personnel are few enough to carry out dressing station duties, and unless each man knows his allotted task so that it comes automatically to him something is sure to go wrong when the rush comes. This allotment of duties is a very necessary procedure when dealing with Indian personnel of the types which are found in medical units, as they are not renowned for showing initiative. Two valuable and instructive days were spent in this detail work, and on the third a fully pitched M.D.S. was opened up in camp, and the details of its working demonstrated practically to "A" and "B" Companies by the Headquarters personnel who are responsible for the running of the M.D.S."

Exercise V.—Extract from Operation Order, No. 10.

"A Turkish division is bivouacked between the 15th and 16th M.S. on the Haripur road, with an advance guard of 1,000 rifles and four pack-guns, digging in on the line 3rd H in Chhappar Hardo—C.G. at Hatar (milestone 8·6). Our main body is at Taxilla (milestone 1). The 12th Infantry Brigade will make a night march (vide march table), drive back the hostile detachment and take up a position to cover the destruction of road and rail crossings over the Dalla Khas road. On completion, the Brigade Group will withdraw south of the River Haro to its present position. The F.U.P. (forming up position) will be along a line drawn east and west across the railway from the eighth milestone (Haripur-Usman-Khattar-Taxilla road) to a point 500 yards west of the railway bridge. The 12th


12TH I.I. BRIGADE EXERCISE AREA NOV. 1925.
Scale 1inch = 2 miles.
N
Khanpur
Mumrhal
Brown House
R. Haro
Gurhi Sayidan
To Haripur 13 M.
Hatar
C.G.
M.S.
Chhappar Hardo
Bhui
R. Dalla Khas
Usman Khattar
12th I.I. Bde.
12 Fd. Amb.
Old C.G.
Kamra
Godhu
R. Lundhikas
Dumrah R.
Taxilla
Kala Serai.
To Rawal Pindi
Grand Trunk Rd.
To R. Pindi 21 M.
6M. to Hassan Abdul.
To Hassan Abdul
To Hassan Abdul 6M
To Hassan Abdul 6M

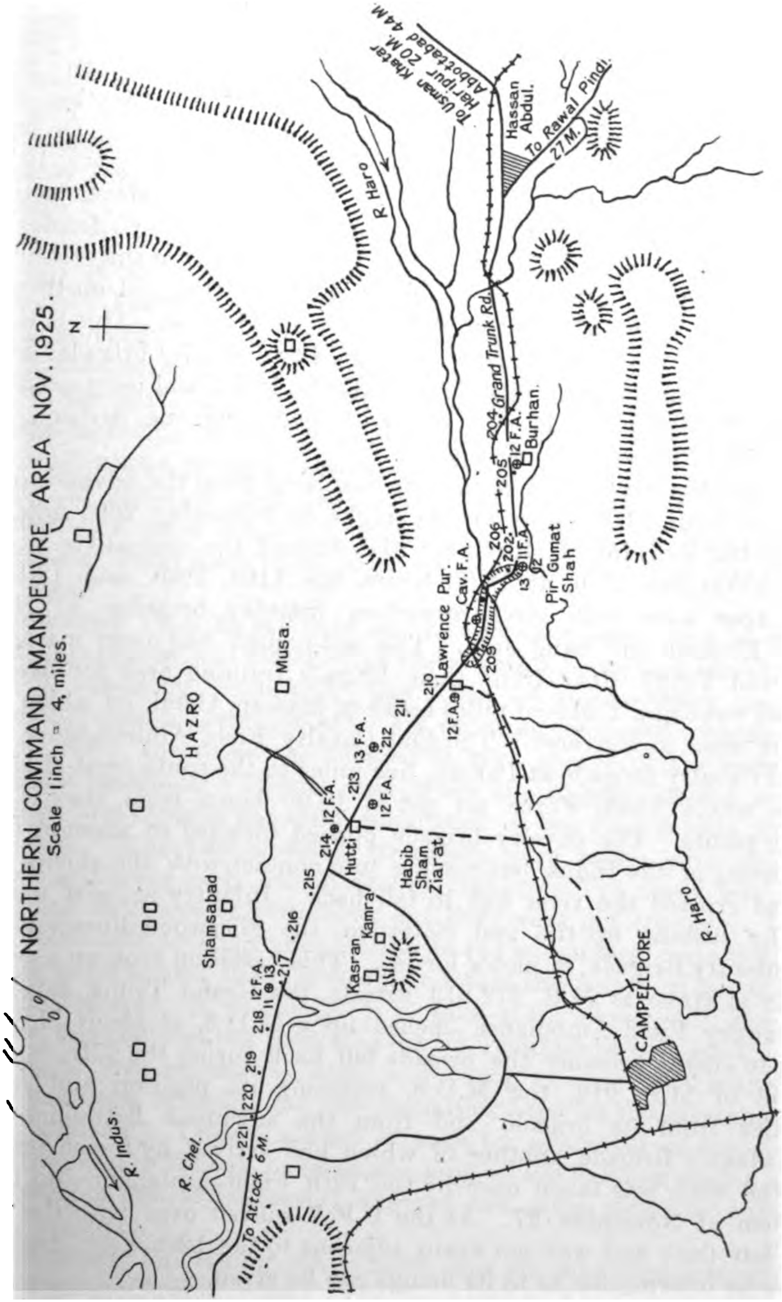
Field Ambulance will establish an A.D.S. on railway 200 yards south of railway bridge on F.U.P., sending forward bearer relay posts to cutting just north-east of O in Chhappar Hardo and C.G. at Hatar as soon as situation permits. The main artery will run along railway to the F.U.P., and be extended to railway cutting just south of the Dhalla Khas with a branch to the C.G. in Hatar."

This exercise gave the field ambulance practice in night marching and night discipline when near the enemy, and in the difficult task of keeping in touch with advancing troops in the dark, and in an attack at dawn. The saving feature was the very definite main artery along the railway, an excellent example of the great benefit to be derived by a field ambulance when such a line is detailed in orders.

Field ambulance orders were issued as follows: "(1) Information and intention; (2) "A" and "B" Companies (less wheeled baggage transport) under Captain M., I.M.S., will parade at 03.00 hours on the 25th instant and march out so as to reach the starting point (Brigade Headquarters) in rear of the 32nd Field Battery R.A. at 03.26 hours. Four ambulance carts and two wheeled stretchers will be taken and casualties evacuated to the M.D.S. at main camp."

The instructions were carried out, a stretcher squad being sent also overnight to reach regimental M.O. for the purpose of establishing communications with front bearer relay posts, when R.A.P.'s were established. The ambulance carts were located at suitable spots on the main road, from whence they could be brought to the A.D.S. across country as soon as dawn broke. Communications were not opened up with the unit R.A.P.'s until long after the attack had commenced. The difficulty of judging distances at night for placing of bearer relay posts was appreciated. The evacuation of casualties at night could not be practised, as unfortunately no practice casualties were ordered to fall out; but with a known main artery so well marked as was the railway, there should have been no great difficulty in maintaining a good line.

Such were the exercises gone through preparatory to the main manœuvres, which were to last about four days and were expected to be of a strenuous nature, as indeed they proved to be. Arrangements had been made by the directors for the "falling out" of a considerable number of casualties, between 600 and 700, who were to be fed with at least one hot meal at the field ambulances before being returned to their units. Four motor ambulance cars had arrived for attachment to each field ambulance in addition to the bullock tongas, which were now relegated to a very posterior position; it was surprising how the latter kept up with the marching field ambulance, much to the detriment of the poor bullocks, it is to be feared, fine ones though they were. The 12th Field Ambulance had in addition four mule-drawn A.T. carts, representing horsed ambulance transport. They were fitted with sacks filled with grass to make them more comfortable.


NORTHERN COMMAND MANOEUVRE AREA NOV. 1925.
Scale 1 inch = 4, miles.
N
HAZRO
Musa.
Shamsabad
Kasran
Kamra
Hutti
Habib
Sham
Ziarat
Lawrence Pur.
Cav. F.A.
12 F.A.
13 F.A.
11 F.A.
Pir Gumat
Shah
Burhan.
Grand Trunk Rd.
Hassan
Abdul.
To Rawal Pindi.
27 M.
To Usman Khatar
Haripur 20 M.
Abbottabad 44 M.
R. Haro
R. Haro
CAMPBELLPORE
R. Indus.
R. Chel.
To Attock 6 M.

Manœuvre Exercises.

The general idea for the manœuvres was briefly this : Punjab (capital Lahore) attacked Doaba (capital Rawalpindi) and drove its force back towards Abbottabad, occupying Pindi and pressing with two cavalry brigades and one division (less one infantry brigade). Scythia (capital Peshawar) is mobilized and on the verge of joining Doaba. On learning of the practical certainty of this on the night of November 25th, 1926, the Punjab Government instructs its C. in C. to take whatever action he considers necessary to deal with the situation. The C. in C. decides to try and prevent the junction of Scythia and Doaba by seizing the crossing over the River Indus at Attock, twenty-eight miles to the west-north-west of Hassan Abdul, by which crossing Scythia would advance. This is not successful and the Scythian force, consisting of two cavalry brigades and one division (less one infantry brigade) crosses the Indus and is opposed by the available Punjab Force of one cavalry brigade and one division (Khaki Force). Both forces have other arms.

The development of the situations resulting from the advance of these two forces from 18.00 hours on the night of November 26th until 11.00 hours on the morning of November 31st formed the manœuvre exercises.

On November 26th, at 18.00 hours, the 11th, 12th, and 13th Field Ambulances were with their respective infantry brigades at Haripur, Usman Khattar and Sang Jani. The last-named had been marching up the Grand Trunk Road from their brigade training area for five or six days and were now fourteen miles south of Hassan Abdul, on which all the brigades were to converge. The 2nd Cavalry Field Ambulance was with the 2nd Cavalry Brigade at Panian, five miles to the south-west of Haripur.

The whole Khaki Force set out at 18.00 hours from their different starting points. The cavalry brigade pushed forward to attempt to seize the crossing of the Indus, but coming into contact with the enemy cavalry who had crossed the river had to fall back. Infantry support was given them by rushing up the 2nd Battalion, the Sherwood Foresters of the 12th Infantry Brigade, in motor lorries. This battalion took up a defensive position at Hatti at M.S. 212-213 astride the Grand Trunk Road. The 2nd Cavalry Field Ambulance opened up a M.D.S. at about M.S. 20.05. Owing to enemy pressure the brigade fell back during the 27th into a line in front of M.S. 212, the M.D.S. retaining its position and receiving casualties from its brigade and from the advanced battalions of the 12th Infantry Brigade, another of which had arrived by forced marching, until the work was taken over by the 12th Field Ambulance on the late afternoon of November 27. As the C.F.A. moved over with the cavalry to the left flank and was not again adjacent to the 12th Field Ambulance, no further information as to its doings can be given.

As regards the 12th Field Ambulance, the following extracts from 12th Infantry Brigade Group Operation Order, No. 1, issued at 14.30 hours on November 26, 1926, is given :—

"The first division is concentrating to-night in the area River Haro on Haripur road—Hassan Abdul-Pir Gamat Shah. The 12th Infantry Brigade Group (less 2nd Foresters, embussed to form with the cavalry a protective screen) will march to the area Laurencepur-Burhan to-night (via the Godho track—Haripur road) operating as advanced guard to the division. The march will be as per march table. . . . 12th Field Ambulance will leave the starting point at 18.24 hours (in rear of the 5/7 Rajputs). The 22nd Field Brigade R.A. and wheeled transport of whole brigade group will march by the main road via Taxilla-Kala Serai, being clear of the latter by 21.20 hours, and will halt at road junction just west of Hassan Abdul . . . First line carts and train will follow in rear of 12th Field Ambulance. Pack transport only will accompany units. One British officer from each unit will march with Brigade Headquarters, and on arrival at the destination receive from the staff captain the bivouac area allotted to his unit. One man will be detailed to lead each mule. Units will march close up. Cover from the air will be taken on the march, and by dawn all troops must be absolutely hidden and remain so throughout the day. No lights or fires will be allowed before 07.00 hours. Motor ambulances will leave Usman Khattar at 06.00 hours on November 27, and be clear of Serai Kala by 06.30 hours, and join their own units in the bivouac area."

These orders affecting the field ambulance have been given at length, as much importance was attached to the advance being undetected. The route to be taken by the infantry was direct by cross-country tracks for about seven miles, a saving of some six miles as compared with the road route, for which an officer was detailed to take charge of the ambulance and baggage transport. It was dark when the column started and the dust was at first intense, the field ambulance in the rear getting the full benefit of it. The two wheeled stretchers were taken with the field ambulance and were early called into requisition. The track was rough for them and in places very narrow, but they were got through. It was expected to be able to transfer casualties to the ambulance carts at Hassan Abdul, but as on arrival there it was found that the transport column had been much delayed, it was decided to take them along with the field ambulance, especially as the road (the Grand Trunk) was now good.

The night was excessively cold, and owing to lack of transport no blankets had been brought, and the casualties lying on the stretchers felt the cold intensely. (Moral, always arrange for a blanket or two.) The I.H.C. men found it difficult to resist smoking at the halts on such a night, and malefactors had to be sternly checked and were made to push the wheeled stretchers.

The necessity for taking cover from the air was demonstrated on approaching the Haripur road. The brigade had halted under cover of trees until the time for debouching on to the road arrived, the march to this point having been made much faster than was expected. The moon had

arisen, and the sounds of wheeled transport on the road came to our ears, and in the near distance a well-marked line of road could be made out. The approach of an aeroplane was heard, and it was proved to be an enemy heavy bomber, and it dropped its bombs (indicated by coloured lights) along the transport moving along the middle of the plainly to be seen white road. The transport was the baggage and supplies of the 2nd Cavalry Brigade, which had pushed forward from Panian. When the 12th Brigade finally marched on to the road it was very careful to march at the side under cover of the trees.

The remainder of the march was uneventful, the unit arriving at its bivouac area at Burhan (M.S. 205) at 2·30 a.m., after a march of about fifteen miles. The bivouac area allotted to the field ambulance was the two sides of the main Grand Trunk Road for a length of about sixty yards, under the trees which lined each side of the road. The personnel were placed on the near side, where they immediately threw themselves down and slept, so that they were with difficulty aroused when the transport arrived in about one and a half hours' time with the baggage, and was parked under the trees on the side of the road. It was not an easy matter finding the beginning and ending of one's own transport in the dark, and separating it out without stopping the long line of moving vehicles. In fact the first two or three carts passed the parking ground before they were recognized with certainty, but they were at once pulled out of the line.

The men off-loaded their kits in the dark, managing to sort them out somehow or other in a marvellous fashion; but daylight revealed a mass of flotsam and jetsam round the unloaded carts, and the carts of the different companies much mixed up on the limited ground.

The motor ambulances arrived at 08.00 hours and were parked on the near side of the road under the trees, and came in useful for sheltering a few casualties that occurred, as the field ambulance was remaining closed. At 11 o'clock an evacuation car, representing a M.A.C. working under the A.D.M.S., relieved us of these sick, and in fifteen minutes more the field ambulance was besieged by a host of inspecting officers from manœuvre headquarters, who all arrived within a few miuutes. These consisted of the D.M.S. (India), D.D.M.S. Northern Command, A.D.M.S. Khaki Force, G.O.C. Northern Command (Director of Manœuvres), and G.O.C. Khaki Force, with their respective staff officers.

Instructions had been received from Force Headquarters that on arriving at the bivouac area the field ambulance would cease to be under the orders of the 12th Infantry Brigade Commander, and would reassume its rôle of a divisional unit. No arrangement had therefore beenmade to send any detachment with the 3/9 Jats, who had advanced to a forward outpost position as part of the advanced guard in the cavalry area in front of the 2nd Cavalry Field Ambulance M.D.S. The G.O.C. in C. interrogated the O.C. Field Ambulance with a view to finding out his knowledge of the position of the units of the brigade which he was serving, or rather

had just been attached to. Fortunately, he was able to show some small knowledge in this respect. Whether it satisfied the G.O.C. or not is another matter.

Both animals and men fared badly to-day as regards rations, only a portion materializing.

At 02.30 hours the O.C. attended a conference at 12th Infantry Brigade Headquarters, when information was given denoting an early move forward for the brigade.

At 17.30 hours it was observed that the battalion immediately in front (the 5/7 Rajputs) was getting ready to move, and at the same time a D.R. brought medical operation orders, from Force Medical Headquarters at Hassan Abdul, which instructed the field ambulance to march at 18.00 hours to Pir-Gumat-Shah (M.S. 207) and there to form a M.D.S. and to open an A.D.S. at Laurencepur, and send out bearer relay posts to serve the 12th and 13th Infantry Brigades, the march to be in accordance with the orders issued to 12th Infantry Brigade. These medical operation orders had been issued to signals two hours before receipt. No brigade orders and march table were received until the following morning, consequently the move was at very short notice. It may be said here that considerable difficulty and delay was experienced throughout in regard to the receipt and delivery of orders and messages, and eventually the A.D.M.S. and D.A.D.M.S. found it more satisfactory to come and give their orders verbally themselves.

Fortunately preparation had been made in case orders were received at short notice. So the field ambulance moved off in rear of the 5/7 Rajputs at the appointed hour, "A" and "B" Companies with their transport leading. Verbal orders had been given to the officers in charge of "A" and "B" Companies to march straight on to Laurencepur and there to form an A.D.S. under O.C. "A" Company, O.C. "B" Company going forward with the bearers of the two companies and getting in touch with M.O.'s of the two brigades when they should reach their positions (13th Infantry Brigade was only just commencing its march forward from Hassan Abdul). The O.C. Field Ambulance rode ahead to the Pir-Gumat-Shah area to choose his site (he had a previous knowledge of this area and knew which spot to make for), which he found occupied by a battery of medium artillery, but fortunately on the point of being vacated, thus leaving sufficient space when cleared of scrub for his fully opened unit. There was a good, clear, roomy site for the sick tents, space in the rear for the personnel, and in front amongst scrub an area for his transport near the road. There was an entrance road which could be used for motors, and with some work put on to it a track that would serve as an exit road for them. Water was available from the River Haro half a mile distant, and from a stream a quarter of a mile off the road. This information was gathered from the departing artillery officer and saved a wandering search.

Very speedily the field ambulance arrived, "A" and "B" Companies

continuing straight ahead, and Headquarters coming on to the site. Transport was parked and the camp marked out as decided upon. Scarcely had this been done when the D.A.D.M.S. came with instructions that the 13th Field Ambulance was coming up to the same site to open up there too, as a M.D.S. There was nothing for it but a complete relaying out of the site, to say nothing of a considerable shrinkage of the ground available for the 12th Field Ambulance, in order to make room for No. 13 Field Ambulance. The transport had to be moved back to some irregular ground in rear, a small office unit already there and settled in for the night having to be asked to change its site to allow the ambulance to get in.

The scrub-covered ground was rather naturally left for the 13th Field Ambulance. It was a good, flat piece of ground, and would do quite well when cleared. It was decided to make the entrance and exit road pass between the two field ambulances, which would have their reception tents on each side of this road, and car-loads of casualties could be taken in alternately, the position of the reception tents being so arranged that two cars could off-load at the same time. A new and less suitable parking ground for motor ambulances was also arranged for, the original one being on the scrub now to be occupied by No. 13 Field Ambulance.

The work of pitching the M.D.S. tents and preparations for the reception of numerous casualties were carried on with in the dark, lights not being allowed and the moon not having yet risen. But when it did rise work was much facilitated, and by 10 p.m. the dressing station was sufficiently completed to be able to cope with anything that might come, though minor additions continued to be made for another hour. Rations for the A.D.S. personnel were sent up with two motor ambulances, word having been early received that it had been established at the appointed site on the side road to Laurencepur Railway Station, at about M.S. 210, and that bearers had been sent out to the 12th Brigade units. During the camp preparations a N.C.O. sent in advance from the 11th Field Ambulance arrived and wanted a site for them. A suitable one was suggested to him, about 300 yards before reaching the 12th Field Ambulance.

At midnight, the men having fed and turned into their bivouacs (except the guard), the O.C. wandered round the outskirts of the camp surveying adjacent ground which had been allocated to other small detachments, such as signals and also a portion of Force Headquarters, and noted a small unoccupied area adjacent under trees and suitable for an unopened field ambulance, but access to it was difficult. He then turned in to his bivouac until 03.00 hours, when he was awakened by the O.C. of the 11th Field Ambulance asking for a site, as the one previously recommended was now occupied by another unit. The site under the trees was shown to him, which he gladly seized upon and quickly occupied, as there was no need for him to open up. The bivouac was again sought, but at about 03.30 hours the 13th Field Ambulance arrived and had to be shown their ground

and the arrangements for the lay out of the combined dressing station. (The 13th Brigade had marched on to their positions alongside and to the north of the 12th Infantry Brigade.) About two hours' rest was now snatched, till 7 a.m., when completion of details and straightening up of camp was again started. No. 13 Field Amublance now set about completing the cutting down of scrub, road-making, pitching of tents, etc., and very soon made their unit into a going concern to work in with the 12th Field Ambulance. The motor ambulance cars of the 13th Field Ambulance had been placed at the disposal of O.C. 12th Field Ambulance by A.D.M.S. for clearing the A.D.S. if required.

At 08.30 hours the O.C. 12th Field Ambulance visited his A.D.S. at Laurencepur. The site was a poor one, on a sandy cultivated field; the adjacent side road was crowded with transport and mounted troops, and the water supply was somewhat restricted in amount. O.C. "A" Company had improvised overhead shelters with tarpaulins and latrine screens, and two tents from the Headquarters had been brought along with the company. There were all the immediate requirements for dealing with casualties when they should arise. The rations sent overnight had been pulverized on the way by being sat upon, and had also apparently suffered from evaporation. All the bearers under O.C. "B" Company were out in the forward area with wheeled ambulance transport for sending back casualties. The rationing of these forward parties was carried out with difficulty owing to their scattered situations. These and other details were dealt with by the O.C., who, on his return to the M.D.S., asked the O.C. 13th Field Ambulance to arrange to take over collection of casualties of the 13th Brigade, as the frontage was too wide for the bearers of one field ambulance, and this he did.

At 10.00 hours signals delivered the brigade orders for the previous night's march and operations, which somewhat cleared up the why and the wherefore of our moves. These had been issued to signals at 19.45 hours on the 27th, and were as follows:—

"Two hostile cavalry brigades and an armoured car company are in possession of the Kamra position, with advanced troops along the line Hatti Rest House, Hill X. The 2nd Cavalry Brigade on right and 2nd Foresters left are holding the line across M.S. 212.7, with armoured cars blocking the G.T. Road. The 13th Infantry Brigade will take over the protection of the Laurencepur defile from the 12th Brigade and will move to area Musa to the north-east of the 12th Brigade. The 12th Infantry Brigade will relieve the 2nd Cavalry Brigade astride the main road, moving forward to-night, and will secure the Habib-Shah-Ziarat position to the left of the G.T. Road. The attack will commence at 22.00 hours. 12th Field Ambulance is opening an A.D.S. at Laurencepur, and will collect casualties from the brigade."

Extracts from a copy of force orders on which the above 12th Infantry brigade orders were based, received later, stated: "12th Field Ambulance

will open an A.D.S. at Laurencepur, relieving the Cavalry Field Ambulance, which will join its Cavalry Brigade. 2nd Cavalry Brigade will move to vicinity of Laurencepur and operate to secure our left flank. The main artery will follow the G.T. Road."

A few battle casualties and some real sick were now being brought in. The arrangements for dealing with these were all in order, and they arrived from the A.D.S. in motor ambulances and were then dealt with in the orthodox manner, the personnel passing them through all the various stages. They were finally given a hot meal, which was ready for them, and the practice casualties then sent back to the A.D.S. by returning ambulance cars, from whence they rejoined their units with more or less rapidity. The seriousness with which the I.O.R. casualties took the whole procedure was good to watch. There were difficulties in some cases when it came to the feeding, as certain of the I.O.R.'s refused to take food from the I.H.C. cooks as not being of high enough caste. Persuasion or the lack of other food soon overcame the difficulty.

The real sick were evacuated by the acting M.A.C., working under the A.D.M.S., to a railway reception station at Taxilla, from whence they were entrained to the hospitals in Rawalpindi.

The number of practice casualties actually received was only a very small portion of those who were given casualty tallies by the units. There seemed to be no anxiety to leave their units, despite in some cases some very hard marching day and night and long periods without food. Only about one-tenth of the number expected passed through the field ambulance.

With the advance to the Habib-Shah-Ziarat position the A.D.S. had got left far behind (about three miles), but the officer i/c bearers had established relay bearer posts along the road and also a car-loading post, a light Ford car being used as well as the mule-drawn ambulance carts; so as the casualties which were coming in were few, it was considered by the officer i/c A.D.S. that it was not necessary to advance it for the present, in view of lack of information as to our being able to hold the line.

At 12.45 hours the M.D.S. was visited by the D.M.S. and D.D.M.S.N.C. and their staff officers, together with a distinguished foreign attaché in the person of the D.M.S. of the Persian Army. Just as they came into camp a cartload of casualties arrived from the A.D.S. which they had just left. The D.M.S. remarked on the quickness of the evacuation compared with the old bullock tongas with which field ambulances in India till now have been equipped.

No. 13 Field Ambulance was now in going order, and casualties were being taken in by it and the 12th Field Ambulance, as prearranged.

In discussing matters the D.M.S. considered the A.D.S. too far back from the front line, in which he was doubtless right, as he, being able to pass through the lines of the opposing force, was able to see the exact position of things better than those some distance to the rear of one side. This

criticism raised the question whether it is one of the duties of a field ambulance commander to leave his main charge and follow up the lines of his bearers to the R.A. posts, to satisfy himself that communications are being maintained and to rectify faults. Whilst this is possible and at times necessary in static warfare, such as trench warfare, in mobile warfare over a wide front it is not feasible, and should not ordinarily be necessary with a bearer officer in front, unless the O.C. has reason to believe that the services in advance of the A.D.S. are not being carried out as efficiently as they ought to be.

However, immediately on the departure of the D.M.S., the O.C. took a car again and went forward in search of Brigade Headquarters, to find out the exact situation. The advance car-loading post was now at milestone 212, with a wheeled stretcher relay post at milestone 213, a few hundred yards behind the front line. After visiting advanced Divisional Headquarters, and consulting with the Brigade Commander, the latter, after some hesitation, agreed to the bringing up of a forward A.D.S. to the vicinity of milestone 213. Verbal orders were issued to O.C. "B" Company to open up at once a forward A.D.S. in this situation, notification being sent to A.D.M.S. 11th, 12th and 13th Infantry Brigades and 2nd Cavalry Brigade. The Officer i/c A.D.S. at Laurencepur was instructed to make preparations for closing down, but to remain open for the present. O.C. "B" Company was fortunate in having an additional officer attached to him, as it enabled him to carry on with his duties of officer i/c bearer party, and to utilize his additional officer in opening up the forward A.D.S. The car-loading post was now advanced to the F.A.D.S. It is more than possible that in actual warfare this would not have been feasible by daylight, as artillery and aeroplanes would have rendered the G.T. Road practically impassable during the day.

The O.C. Field Ambulance returned to the M.D.S. at 17.00 hours and, after attending to certain matters, was proceeding to the "Mess" to partake of a much-needed cup of tea, when orders arrived from the A.D.M.S. as follows :—

"No. 12 Field Ambulance will close its M.D.S. at Pir-Gumat-Shah and hand over its cases to No. 13 Field Ambulance. No. 12 Field Ambulance Headquarters will march to Laurencepur and join its A.D.S. by 07.00 hours on November 29, remaining there closed. No. 13 Field Ambulance will immediately open an A.D.S. at milestone 212 and receive all casualties from the 12th and 13th Infantry Brigades. The A.D.S. at Laurencepur will close at 07.00 hours on 29th instant on arrival of Headquarters 12th Field Ambulance."

This meant the cancelling of the orders issued for the formation of the forward A.D.S. at milestone 213. Orders were therefore sent to the officer i/c forward A.D.S. to close at 07.00 hours on 29th instant and withdraw to M.S. 212 after handing over his duties to the officer i/c A.D.S. 13th Field Ambulance. Infantry Brigades, A.D.M.S., A.D.S. and No. 13 Field Ambu-

lance were notified. Instructions having been issued for evacuation of sick and the closing of the M.D.S., the O.C. proceeded to take his cup of tea.

Most of the camp was struck by dusk, though the loading up had to be done in the dark so as to leave as little as possible for the morning. Réveillé was a very early one, darkness being our lot again, and the unit did not show that alacrity in turning out that might have been apparent had the hour been a later one. But by dint of progging blanket-covered bundles, to say nothing of a few mild foot-pushes (?), the unit was induced to get on the move, and by 05.30 hours moved out of camp by moonlight and reached its A.D.S. at Laurencepur just before 07.00 hours. The A.D.S. had spent a peaceful night and seemed to object to having their slumbers thus disturbed. As a matter of fact it was little wonder that the men were tired, for there had been continuous hard work since the morning of the 26th and only snatches of sleep. A field ambulance following troops in action is no place for those expecting a life of ease.

Nothing further has been said about No. 11 Field Ambulance, and nothing much is known of its doings now or later, as it literally vanished into the blue. After remaining unopened during the morning of the 28th, it received orders in the early afternoon to convert itself into a pack unit and accompany its brigade into the roadless area on the right flank, leaving its wheeled transport to rejoin it later. Its motor ambulances were placed at the disposal of No. 13 Field Ambulance. In two short hours the O.C. managed to sort out such equipment, blankets and rations as he considered essential to take with him, and to load them on his few pack mules in time to join and march off with his brigade. Their casualty-carrying capacity was limited to their bearers, and their only hope of clearance in case of casualties was to send by hand-carriage to the bearer relay posts on G.T. Road, a distance in some places of four miles, though at one point, Hagro, it would be possible to get an ambulance car within close touch if required, and if communications with No. 13 Field Ambulance could be established. The flanking movement performed by this brigade eventually took them across the G.T. Road in the further advance, and casualties found their way to the A.D.S. of the 12th Field Ambulance, formed later, on the afternoon of the 29th, at Hatti, near milestone 214. The cold, frosty nights with only great coats, and the lack of rations made the march an extremely trying one, and a batch of Gurkha "battle casualties," brought in at nightfall of the 29th, were very glad of the warm food and shelter to be found in the A.D.S., and gladder still when they were given blankets and told that they need not go out into the night and the blue to rejoin their battalion, which was in the field, until the following morning.

This incident again brought out very forcibly the conclusion arrived at early in brigade exercise, that in this country a field ambulance, in order to carry out its functions, viz., the collection, treatment (and often retention) and evacuation of its casualties, must be provided with, or be capable

of being provided with, at short notice, transport (both equipment and ambulance) which will make it independent of roads.

To return again to the 12th Field Ambulance, after the transport was parked alongside the A.D.S. at Laurencepur, and very welcome food for all ranks speedily prepared, the O.C. went forward at 08.30 hours to find "B" Company and get in touch with forward happenings. This company was found at milestone 212, adjacent to the A.D.S. of No. 13 Field Ambulance, having arrived according to the instructions issued and having withdrawn their bearers after replacement by those of No. 13 Field Ambulance. They were very hungry and short of rations, which was remedied on the return of the O.C. to the field ambulance. The officer in charge of forward A.D.S. stated that on arriving at the selected site near milestone 213 he found that a battery of artillery had in the meantime occupied it, and a less advantageous position had to be utilized. This incident is mentioned as it is of frequent occurrence. The fact that sites which are suitable for A.D.S. are so often the ones selected and occupied by artillery must not be forgotten, and if it is not possible to avoid their vicinity the A.D.S. must be prepared for a warm time from enemy counter-shelling.

At 12.30 hours verbal orders were brought to Headquarters 12th Field Ambulance by D.A.D.M.S. to open an A.D.S. at Hatti, just short of M.S. 214, as soon as possible, as heavy fighting was taking place in the vicinity. Orders were issued for "A" Company to set out immediately, and the O.C. proceeded at once in a heavy motor ambulance to "B" Company, at M.S. 212, placed in the car an officer, one B.O.R. and six men, and light equipment, and sent them off to start the A.D.S., which they did at 13.15 hours, in time to receive the first casualties (three B.O.R.'s), which came in fifteen minutes after opening. The remainder of "B" Company followed at once by march route, and two more motor ambulances were taken on from the car stand of the A.D.S. of No. 13 Field Ambulance. By 14.00 hours the whole A.D.S. of "A" and "B" Companies had arrived, and bearers had been dispatched to get in touch with the units, which was speedily done through R.S.B.'s bringing in casualties direct. A message to each Brigade Headquarters was sent by telephone from Force Advanced Headquarters at 13.10 hours notifying the position of the A.D.S. This appears to have been one of the few messages sent out by No. 12 Field Ambulance that successfully reached its destination; messages sent through Brigade Headquarters to M.O.'s of battalions to ascertain location of R.A.P.'s rarely elicited replies, and touch was usually obtained by M.O.'s sending back bearers of squads attached to them.

A carload of casualties was speedily obtained, and these were dispatched to the M.D.S. of No. 13 Field Ambulance at Pir-Gamat-Shah, the O.C. 12th Field Ambulance travelling back on the same car. Just before reaching Laurencepur the car was held up by a staff officer, stating that

no return traffic across the River Haro to Pir-Gamat-Shah would be possible for one and a half hours, owing to the passage over the bridge of a very large motor convoy. The carload of patients was therefore switched down the side road to No. 12 Field Ambulance, where they were off-loaded and attended to pending the opening of the road again for down traffic; a temporary dressing station was dispatched to the spot where the hold-up commenced, in order to take charge of any more casualties coming down from the front by car and similarly held up, and a message was sent back to A.D.S.'s by a returning ambulance to hold up casualties, if possible, for one hour before dispatching them. In this way steps were taken to counteract some of the ill-effects which blockage of the bridge from whatever cause might produce in the system of evacuation—an occurrence which might very likely happen on active service. At 13.30 hours the road was again clear, and the casualties were sent on to No. 13 Field Ambulance M.D.S., the temporary dressing station at the "hold up" being withdrawn.

At 14.30 hours verbal orders were given by the A.D.M.S. for the bringing up of the 12th Headquarters to join the A.D.S., which move was completed by 18.30 hours. Some eighteen or twenty casualties, mostly lying cases, were evacuated to No. 13 Field Ambulance. About dusk rumours came in that the "Stand Fast" had been sounded, which was later confirmed on visiting Force Advanced Headquarters Signal Station. The unit therefore settled down to a very welcome peaceful night bivouac.

It was at this point, when troubles seemed to be on the verge of ceasing, that a conscience-stricken stretcher squad made the awful confession that they had been captured by the enemy on the night of the 28th and 29th, taken before a staff officer, questioned, and then released after two hours. They had then found their way back to their bearer relay post, and had kept perfectly mum about the whole proceedings. It would be interesting to know how much information the staff officer got out of them. Not much, I fear.

On the following morning rumour again spread that the "No-Parade" call had gone. This was strengthened by the belated arrival of a stretcher squad, which had remained out all night and whose whereabouts no one knew, the officer who placed them out having had to return to Pindi the previous evening; the squad stated that the units in front of them had marched off. Eventually orders were received to proceed to the units dispersal camp at milestone 217, four miles further on, which was reached in the early afternoon.

No. 11 Field Ambulance was found there waiting for their wheeled transport, from which they had been separated for two days, to roll up. No. 13 Field Ambulance arrived late in the afternoon very disgruntled, having had to march eleven miles from Pir-Gamat-Shah, past which they would have to march again on the return journey to Rawalpindi. This seemingly unnecessary march was unavoidable, as the whole force had to disentangle its transport, which had been drawn from many different

transport units and stations, in order to enable these units to march back to their own areas.

It fell to the lot of the field ambulances to have their wheeled transport taken from them and to be allotted camel transport. For the information of those who have no experience of camel transport, it may be stated that the daily loading and unloading with inexperienced personnel is a perfect nightmare, and when the camels do not arrive in camp till dusk and are off-loaded in the dark, when rearrangement of packages into camel loads has to be done before turning in, and when striking tents and loading has to be done again in the dark on the following morning, it is not to be wondered at that the tempers of all are sorely tried, more especially also when, as in this case, the marches are long ones, close on fifty miles having to be covered in three days, and when the men are tired.

Now that the excitement of manœuvres was over, as the result of heavy and fatiguing marches, the numbers of sick increased somewhat, and transport assistance had to be given to some, and others had to be evacuated through the railway reception station, which had fortunately been advanced to Hassan Abdul. On the last stage the motor ambulances were sent on ahead and were somewhat heavily laden with war-worn and foot-sore heroes, who did not count as casualties, as they were not being sent back to hospital.

Such then is an account of happenings covering a strenuous month. In criticizing the movements and uses of the field ambulances, it must be remembered that these units were out for training, and moves that would not have been necessary in actual warfare with so few casualties were here carried out for training and demonstration purposes. Examples of such were the use of two field ambulances in forming one M.D.S., the leap-frogging of both A.D.S. and M.D.S. as the advance occurred, and the pooling of the ambulance cars under one field ambulance to carry out the evacuation. Information was obtained in regard to the detail working of the units, and in regard to desirable improvements in equipment, methods of distribution of loads, distinguishing of medical units by air-craft, etc., and was placed in the hands of those best able to judge of its value. It may be said that the shoulder carriage of stretchers by four bearers was that adopted throughout by the 12th Field Ambulance.

Slight variations in some of the actualities have had to be made in order to help the narrative, as "the fog of war," increased by the lack of communications as far as the medical units were concerned, often descended in thick volumes. The medical services do not come into their own on peace manœuvres, and in the absence of shot and shell proceedings go on at a pace which would rarely be maintained in actual warfare. Should these notes be read by some of those who took part in the events, they are asked to be indulgent as regards any inaccuracies in detail and variations from the truth which they may detect. It is hoped that other readers may find the narrative not only interesting, but instructive as well.

MILITARY HYGIENE AND SANITATION: A RETROSPECT.[1]

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The history of hygiene and military sanitation during the past fifty years covers the most important period as regards the progress of the science and art of the prevention of disease and the maintenance of health in the history of the Army. Not only has our knowledge of the science of hygiene increased to an extent that makes a retrospect into the middle 'seventies of last century almost like a glance into the Dark Ages, but at the same time our practical application of that knowledge, in other words the art of sanitation as applied to the circumstances of military life, has increased to an almost equal extent.

In studying the history of this progress I do not intend to encumber this paper with more figures than are necessary to illustrate my points, nor do I pretend to adhere meticulously to exact dates of the various changes that have taken place. My aim is to give a general sketch of the progress that has been made rather than a step by step account of the advance by which it has been achieved. Military sanitation is based on two factors: (1) The advice given by the medical officers of the Army, each in his particular sphere of responsibility; and (2) the carrying into execution of that advice by staff and regimental officers. To give good and trustworthy advice the medical officer must not only know the laws of hygiene, he must also be intimate with the details of military administration, the general conditions of military life, and the character and work of the soldier. To carry out such advice, in an efficient manner, staff and regimental officers must have an appreciation of the importance of sanitation as conducive to the success of the operations of war and a grasp of the basic principles of hygiene. Complete success can only be achieved in the prevention of disease when both parties understand each other's standpoint, trust each other thoroughly, and co-operate with a single eye to their common aim and interest—the good health of the soldier.

The history of prevention of disease in the Army must, therefore, be a history of our advance in knowledge, and at the same time a history of increased mutual trust between the two parties responsible for the execution of the necessary work by which that knowledge is applied.

Though I have written as if the demarcation of duties was definite, this is, of course, not actually the case in practice. Each side must advise the other; each must also help the other in execution. Still, the general demarcation remains, and is an essential part of military administration.

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[1] Reprinted from the *Journal of the Royal Sanitary Institute*, 1926.

I will not encumber this paper with figures, but since a few are necessary to indicate the *termini ab quo* and *ad quem*, and also certain milestones on the line of progress, I will give these at once and be done with them.

To begin with, the ratio of admissions per 1,000 strength to hospitals from all causes in the British Army, at home and abroad, was in the middle 'seventies, in round numbers, 1,060; in the 'eighties, 1,020; in the 'nineties, 850; in the earlier years of the present century, 500; and at present 480. Taking the Army in the United Kingdom only, the total fall has been from 843 to 360; in the Army in India from 1,480 to 660. These figures speak for themselves and need no elaboration.

This advance should, if my statements above be correct, be due to improved knowledge, and improved co-operation between the medical and other arms of the Service.

First, then, as regards knowledge. In addressing a professional audience it is unnecessary for me to dilate upon the general increase in knowledge of the causes and prevention of disease common to both civil and military branches of the medical profession, in the last fifty years. To show how great this advance has been, it is sufficient to remind you of what I wrote earlier in this paper, that a retrospect into the 'seventies of last century was like a glimpse into the Dark Ages. In those days the germ theory was in its infancy; inoculation as a preventive measure (with the single exception of vaccination) unknown; biological methods of the disposal of sewage undreamt of. To what lengths that list might be extended you all know, and yet just fifty years ago died the greatest of military sanitarians, Edmund Parkes. I need not remind members of this Institute of the work that he actually did accomplish with his necessarily limited knowledge, and the limited means at his disposal. What might he not have done if he had possessed that which we now have at our hands for the asking? It was his fate to be born before his time, but his example and his memory will never fail to be the inspiration of all military sanitary officers, in the hope that they, his better equipped successors, may by following his great example emulate his success, since they cannot expect to surpass his merits.

In discussing the advance in knowledge of the basic principles of hygiene in the other arms of the Service, and the increased recognition of the importance of co-operation between them and the Medical Service, I must go to greater length.

The seventies of the last century were marked by two most important changes in military administration, namely, the introduction of short service and the formation of a unified medical department, replacing the old system, under which medical officers were largely regimental officers, wearing the uniform of the regiment to which they belonged. It would be idle to pretend that either of these changes was popular in the Army as a whole, completely as they have since justified the wisdom of their authors. The first entirely altered the nature of the population with which the sanitary

officer had to deal, the latter severed at once the intimate connection between the regimental and the medical officer, which the older system had encouraged. The regimental commanding officer missed the presence of the old surgeon major who had been, in many cases at least, his friend and brother officer for many years, and whom he trusted in both relations. In his place he got a stranger, a young medical officer straight from Netley, whose ignorance of army life was only equalled by his pretension to superior scientific knowledge, and his want of tact in submitting recommendations for the improvement of the sanitary work in the regiment. On the other hand, the regimental medical officer, rudely severed from the regiment which he had come to look on as his home, found himself burdened with administrative duties entailed by the charge of a large hospital, and often of a large station, for the execution of which duties his previous education had in no wise prepared him, and which he found in the last degree distasteful. Worst perhaps, of all, since sentiment plays so large a part in life, he found himself cut off from the regiment whose uniform he had worn for so many years, whose honours and traditions were part of his life, and placed in (what he considered) a new-fangled department without any traditions, and which had still to find its place in the military scheme. (I am, of course, emphasizing the shades of the picture: there were both commanding officers and regimental medical officers who were far sighted enough to realize the necessity and advantages of the new system, little as they liked the inevitable dislocation that it entailed.) As a general corollary there was undeniable friction between the Medical Department and the other arms of the Service, which did not facilitate co-operation or efficient work. I do not intend to refer, except in passing, to the long drawn out discord, evidenced by the various Royal Commissions that discussed the status of the army medical officer during the last twenty-five years of the nineteenth century. They may now be left forgotten in the limbo of "old unhappy far-off things and battles long ago." Nevertheless, they had their evil influence in their time, and they certainly postponed the advent of cordial co-operation between the different branches of the Service, which is the thing most necessary to the prevention of disease in the Army.

It has often been said that the South African War was the greatest God-send that the British Army ever received. In no case is this more true than in the matter of sanitation. The appalling loss from disease in that war, in which the deaths from sickness were nearly ten times, and the deaths from enteric fever alone more than four times, the number killed by the enemy's fire, brought home to the most unthinking and careless of nations the truth that one of the essentials of victory in war was attention to sanitation. The lesson had indeed been written by every campaign that the British Army (or for the matter of that any other army) had ever fought. One would have imagined that the Crimean War alone would have stamped it into the brains and hearts of politicians, but Lord Herbert

was the only man who grasped the lesson, and he, only the first half of it. To his influence was due the founding of the Army Medical School, first at Fort Pitt, and afterwards removed to Netley. He did his best to improve the knowledge of the medical officer. He did not realize that it was just as necessary to teach the regimental and the staff officer that their responsibilities were as great as that of the medical officer in this matter. Not all the work and teaching of Parkes, great as his influence for good was, could produce the mechanism by which alone the advice of trained medical officers could be carried out. In addition, hygiene at that time was a young science, and, like all young creatures (I use this word in its original sense of something created), made many mistakes. Many discoveries made in the earlier years were later seen to be ill-founded, and worse still, as regards the Army, many recommendations, the carrying out of which caused both trouble and expense, turned out inefficacious. So much was this the case that Lord Wolseley, in his otherwise excellent "Soldier's Pocket Book" described a sanitary officer as the most useless officer in the Army, and recommended any general to whom such an encumbrance might in future be attached, to leave him at the base. I hardly think that any general who commanded a force in the late war would repeat the gibe. At the time, however, it had, from the great authority of the writer, an unfortunate influence, especially amongst those senior officers who were especially attached to Lord Wolseley. There was one marked exception, namely, Sir Redvers Buller. He not only fully recognized the value of sanitation in the field, but personally and actively enforced its observance. The result was shown in the far better health enjoyed by the Natal Army when compared with other forces in the South African War.

Fortunately at the close of that war there were two men who not only read the oft-repeated lesson, but had both the sense to grasp its meaning and the power to enforce its teachings. These were Lord Midleton, then Secretary of State for War, and Sir Alfred Keogh (then Lieutenant-Colonel), later Director General of the Army Medical Department.

The first important step taken was the transference of the Army Medical School from Netley to its present site on Millbank. This at once brought the teaching staff of the Royal Army Medical College (as it was then named) into closer touch with the War Office and with the Medical Schools in London. Instead of the cramped and out of date laboratories of Netley, the College was equipped with class rooms which are unsurpassed in Great Britain, if not in the world (that, at least, was the expressed opinion of the numerous foreign delegates who visited the College at the Congress of 1912), and endowed with an increased library grant.

Another great advantage consequent on the change of site was the closer touch maintained between the individual medical officers working in the War Office and the College respectively. The two staffs got to know each other in a way that had never been possible before.

To my mind, the founding of the Royal Army Medical College is one of the outstanding landmarks in military sanitation.

But if the reforms instituted by the two men I have mentioned had stopped there, their work would only have been half done. The other outstanding reform was the education of staff and regimental officers by lectures at the Staff College, at the R.M.C., Sandhurst, at the R.M.A., Woolwich, and to regimental units generally. And, lest the seed should fall on stony ground, the unfortunately necessary whip (I acknowledge and apologize for the mixture of metaphors) was supplied by the inclusion of sanitation in the passing out examinations at Woolwich and Sandhurst, as well as in the examinations for the earlier steps of promotion.

It is these two factors, then, the improved means of instruction for medical officers, and the new system of instruction for regimental and staff officers, that, from the administrative point of view, were the cause of the good health of the Army in France during the late war. It must be remembered that the war was fought over ground where British armies had often fought before, and that those earlier campaigns had always been marked by heavy mortality from dysentery and malaria. Cultivation had probably done a great deal to reduce malaria, but the fouling of the soil by a marked increase in population and intensive cultivation, had not tended to diminish the likelihood of intestinal disease. Yet dysentery was a comparatively rare complaint, whilst the total admissions from enteric fever in four years, for all ranks of British and Dominion troops, were less than the total deaths from this cause in the South African War in two and a half years, where the force engaged was so much smaller. It is true that in other theatres of war, Gallipoli and Mesopotamia, disease was more prevalent, but in those theatres the local conditions rendered the problems exceptionally difficult to deal with: there was no lack of combined effort to tackle them.

So far for administrative questions. To come to more concrete causes it will be necessary to refer to housing, food, clothing, and physical training. As regards the first, though a few of the older barracks still exist, in smaller stations, the improvement in the larger stations has been enormous. Those only who, like the present writer, can remember the old huts at Aldershot and compare with these the barracks that replaced them, can perhaps appreciate the advance that has been made. And since the construction of a barracks influences profoundly the mode of life of the soldiers who have to occupy them, the newer plans have permitted of increased comfort, improved methods of messing, and better sanitation in all directions. In such modern barracks as the Guards' Barracks at Windsor, and the barracks at Redford, near Edinburgh, everything that the soldier can want—food, amusement, and indoor recreation generally—is provided under one roof.

The best witness that can be called on this point is Field Marshal Sir William Robertson, who, in his book "From Private to Field Marshal," contrasts the conditions of the soldier's life at the time when he first enlisted at Aldershot with those that he saw when he served again at

the same station as Chief of the General Staff thirty years later. Space forbids me to retail these changes at length, but anyone interested in the life of the soldier should read that chronicle: there are few books more interesting and instructive.

As to clothing, a few words only are necessary. The modern soldier's working dress is the well-known field-service uniform with which everyone is familiar, which though, for display, it cannot compete with the pre-war red and blue, is infinitely more suitable for a working man's attire (and the soldier is a hard working man) than the more attractive and resplendent uniforms of the old days.

Food is perhaps an even more important matter. Here, again, only those who can remember the dinners with which the private soldier had to be content, even forty years ago, can appreciate the change. Instead of having to eat, at the same table on which he cleaned his accoutrements, food that was badly cooked, and worse served, he now sits down in a comfortable dining-room to food that is not only good in itself, but also of ample variety, decently cooked and served, and substantial in quantity, while the dietary scale is based on scientific principles as to its components and suitability.

To put it shortly, the soldier on enlistment is better housed, better clothed, and better fed than he ever was in civilian life—far better than his predecessors of the 'seventies. Little wonder that his health should be good. In addition he gets plenty of work, is put through the best judged system of physical exercise that I know of, and has far more done for him in the matter of outdoor sport, and indoor recreation, than was conceivable even by the most progressive of military reformers fifty years ago.

A few words may here be said on the question of food on active service. A certain scale was laid down after the South African war for the field service ration which was considered sufficient for the demands of active service in the field. In 1909 and 1910 practical experiments were carried out, as a result of which substantial additions were made to the diet, especially in the matter of fats. This scale, which proved if anything to be redundant, was adopted, with certain modifications, in the last war. It was largely in consequence of this increased scale that the health of the Army was so good in the very trying conditions of the first six months of the war.

I will now touch briefly on physical training and equipment from the purely medical aspect. In 1909, largely owing to the advice of Dr. M. S. Pembrey, then a member of the Army Medical Advisory Board, the scientific study of the life and work of the soldier, in other words of the physiology of military life, was taken up seriously. Since the days of Parkes this study had been allowed to fall into the background, but as a result of Dr. Pembrey's initiative a special class was started at the Royal Army Medical College, whose duty was to study both practically and theoretically the influence on the soldier's constitution of the work demanded of him both in

peace and war. The effect of marching, with and without loads, on the temperature, pulse rate, and blood-pressure was studied personally and practically by the students themselves. They went through the ordinary course of physical training required of the soldier, and their opinions on the different exercises, their merits and shortcomings, discussed at the College on their return from the Guards' Gymnasium, whilst the memory was still fresh. They carried the soldiers' load on experimental marches, comparing the British equipment with that of various foreign armies, of which the College was fortunate in possessing a full collection. After leaving the College these officers were posted to various central gymnasia, where they had the opportunity of instructing the technical staff in the physiological aspects of their work. Since those days the study of military physiology has been much expanded, but the credit for its ever having been seriously taken up is due to the man I have already mentioned. The Army owes him a deep debt of gratitude for the interest he took in the beginnings of the study, and for the liberality with which he placed all his knowledge and gave much of his time to the instruction of the earlier students.

I may now pass to the consideration of certain specific diseases intimately connected with military service. Since so large a portion of the British Army serves abroad in tropical and sub-tropical climates the diseases which I shall mainly consider are those which prevail in such climates, and as the preponderating portion of the foreign service Army serves in India I will use that country as an illustration.

I will begin with cholera: not because this is the most important, as regards prevalence, but because when it does occur its incidence is so sudden, its mortality so dreadful, and its moral effect on the troops attacked so serious that it claims for itself the first place. Enteric fever is a burden, often a heavy burden; cholera is a calamity, and may be an overwhelming calamity. In time of war a severe outbreak of cholera might well decide the fortune of the campaign as rapidly and decisively as a crushing defeat at the hands of the enemy.

In the sixties of last century cholera was an ever-present menace. Every year saw an outbreak, roughly every other year one of appalling dimensions; and, since its incidence was capricious, and as a rule it struck only a few stations in full severity, where it did strike it swept the station it selected as with a besom. In the 'seventies it was still constantly present, but the outbreaks were less severe; in the 'eighties and 'nineties the improvement continued, and during the present century the number of admissions per 1,000 of strength has rarely been more than a fraction per 1,000 of strength. The explanation to my mind is clear. Cholera has disappeared because water supplies have improved, and for no other reason. The connexion of water-supply with cholera was not generally recognized in the 'sixties. In the 'seventies the teachings of Parkes began to bear fruit, and during that decade and the next increasing attention was paid to this matter as the essential connexion between it and the disease became

more and more clearly realized. The culminating point was reached in 1894, when an outbreak in the East Lancashire Regiment, at Lucknow, inseparably associated with the name and gallant behaviour of the late Major-General Sir Henry Neville Thompson (then Surgeon Captain), showed in the clearest possible manner that water, and water alone, was the vehicle by which cholera was ordinarily conveyed to man. Incidentally it demonstrated the powerlessness of the ordinary form of portable filter, then in use, to deal with bacterial infection. Sporadic cases of cholera have occurred since then, and even small outbreaks: such are to be expected as long as the disease continues to be endemic in certain parts of India. It may confidently be expected that it will never again appear in the form which it assumed in the 'sixties and 'seventies.

The outbreak at Lucknow originated a reform in our system of filtration. The story is too long to recount in detail. Berkefeld and similar portable filters were tried for a time, but found too fragile for field service, in the South African War. Eventually, after many experiments and failures, it was not until shortly before 1914 that, mainly by the energy and labour of Colonel Sir William Horrocks, the present form of filtering and sterilizing water cart was introduced. This passed through the test of the late war with brilliant success.

The next disease with which I shall deal is enteric fever in India, since it is in that country that its chief manifestations, in peace time at least, have occurred. Here we are at once confronted with the difficulty of nomenclature. In the 'sixties and 'seventies enteric fever was either rare in India, or at least rarely recognized. As time went on more cases were returned under this heading, and the question at once arises, was this increase due to an actually increased prevalence of the disease, or to the fact that medical officers of the 'eighties and 'nineties were, as regards this disease, using a different dictionary from that used by their predecessors of the 'sixties and 'seventies? The only way to decide this question is, in my mind, to take all diseases with pyrexia as their prominent feature and note their prevalence and mortality during the last sixty years. Using this method we shall, no doubt, include a great many cases of fever which were not enteric, but, at the same time, we shall undoubtedly include all true cases of that disease. (Fortunately for our purpose, in this connexion, the exanthemata are extremely rare in India.)

If, then, a curve be constructed showing admissions for "All Fevers" and the mortality per cent of cases treated, we get the following result. In the 'sixties and 'seventies the admission rate for "All Fevers" was very high, amounting as high as 700 and even 950 per 1,000 of the total strength. At the same time the death-rate per cent of cases treated was low, only twice amounting to 0·8, and being, as a rule, well below that figure. In the 'eighties there was a marked fall in the number of admissions, accompanied, however, by an even more conspicuous rise in the mortality. In the 'nineties the total admissions were slightly lower than in the 'eighties, but

the mortality rose to an alarming extent, culminating in 1896 to 1898 in rates per cent of cases as high as 2·25. The years of the Boer War, 1899, 1900 and 1901 showed a fall both in admissions and deaths, but in the four following years, though admissions continued to fall the death-rate rose to 1·9. From 1904 the death-rate fell steadily, but it was not until 1910 that it reached a level below that of the worst years between 1860 and 1885.

Now, if we were dealing with a single disease we should be justified in saying either that its type had changed, and that it had become more deadly, or, otherwise, that the population concerned had become less resistant. Dealing, as we are, with a group of diseases we are, I think, entitled to conclude that the most deadly of the group had increased in prevalence. I have long since come to the second of the above conclusions. It is notable that the critical year is 1886. That year marks the final disappearance of the old "long service" soldier, and a consequent reduction in the age of the Army. It is remarkable, too, that during the years of the Boer War, when few drafts came from England, and few men went home to the Reserve, the age of the Army increased and the death-rate from fever diminished. As soon as that war was over and young drafts began to come out, the death-rate rose, until in 1904 when inoculation supplied the necessary artificial resisting power. Since then enteric fever has ceased to take the dreadful annual toll of young lives that marked the last fifteen years of the nineteenth century. Inoculation has, in my mind, been the chief cause of the victory over enteric fever in India, a victory only paralleled by its success in the late war.

Improved sanitation, the result of the appointment of special sanitary officers (a step in which, for once, India led the way, owing to the influence of the late Surgeon-General Sir William Taylor) no doubt has had its share. Sanitary work has been better organized, and co-ordination, which previously was sorely lacking, is now the rule. Such measures have had excellent effect, but without inoculation the goal would not have been attained so soon, and in their fight against enteric fever sanitary officers would have been fighting with one hand tied behind their backs.

I will now pass to the discussion of malaria, but very shortly. The diseases included under this heading, though responsible for a high degree of disability, have not since the early 'sixties caused much mortality in the Army in India. The non-fatal fevers, which were so prevalent in that and the following decade, must have belonged mainly to this class. In the 'nineties the admission rate was a little over 100 per 1,000 and fell fairly steadily till 1913, when it was less than half that amount. Since the war it has again risen to nearly 100, and is now about 70. This rise is doubtless due to military operations, since the war, in malarious parts of the Indian Frontier. No one who has not served in India can estimate the difficulty of the malarial problem. That the disease can be kept in check there is no doubt; that it can ever be totally eradicated is impossible. The needs of irrigation, especially in the Punjab, and the presence of a heavily infected

native population, acting as a constant reservoir of infection, render such a hope unduly optimistic. The most interesting example of what can be done, and has been done, is the island of Mauritius. The small garrison of this island suffered severely from malarial fevers during the earlier years of the present century, the admission rate being usually from a quarter to a half of the total strength. In 1908 Sir Ronald Ross visited the island and made certain recommendations. The result may be briefly stated. The total number of admissions for five years subsequent to that visit were just about equal to the average annual rate for the five years immediately preceding it. Mauritius is, however, a small station, and cannot, therefore, be compared in this respect with a sub-continent like India, where troops serve under a variety of different conditions of climate, soil and surroundings.

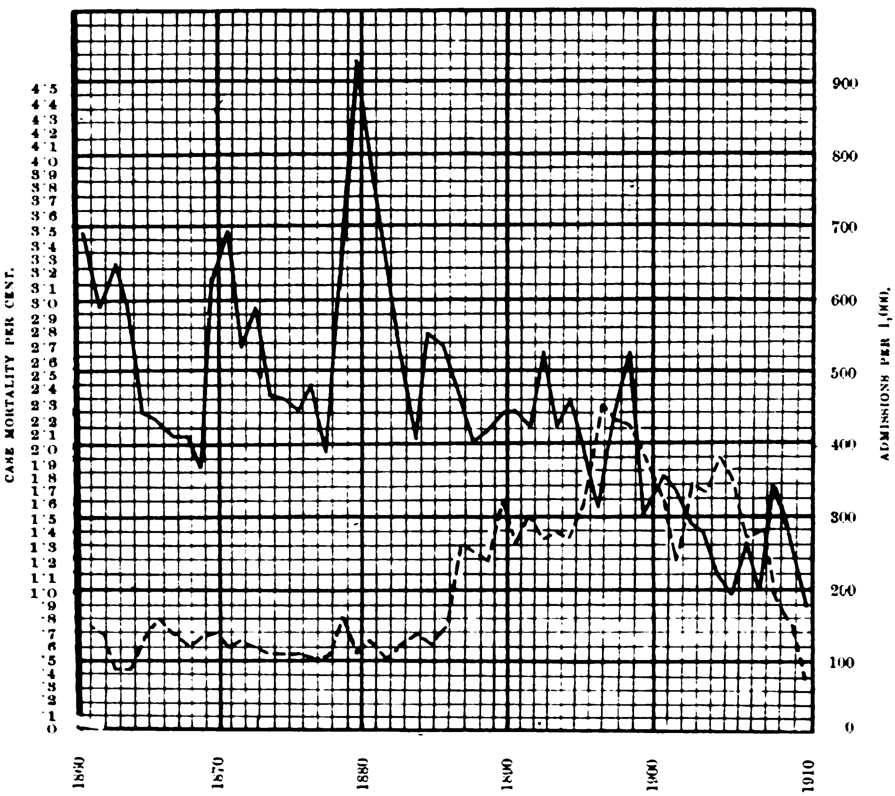
The last class of diseases which I shall consider is that of venereal diseases. In the early 'seventies the number constantly sick from all forms of this class of infection was just below thirteen per 1,000. In 1873 a fall occurred to about nine per thousand, and the number constantly sick continued at that figure till about 1877, rising slightly the year following to about 10·5 The cause of this fall was probably largely administrative, since between October, 1873, and November, 1879, any man admitted to hospital for this class of disease forfeited, by Royal Warrant, the whole of his pay during the period of his treatment. As a result concealment of disease, combined probably with resort to outside medical aid, became frequent. Immediately on the removal of this penalty the constantly sick-rate rose rapidly to over twenty per 1,000 in 1884. From that date there was a steady and almost uninterrupted fall to the year 1900, when the figure was as low as seven. This fall was followed by a rise in the next four years to nearly twelve in 1904, with a subsequent fall to a little over four in 1913, the last complete pre-war year. After the war, in 1921, there was a slight rise to about 5·5, immediately followed by a steady fall to the present figure of 3·3. These are the dry bones of the history of these diseases. A short commentary is necessary.

To go back somewhat. In 1864 the Contagious Diseases Acts were introduced in fourteen principal stations in the United Kingdom, and lasted, with some modifications of a minor nature, till 1886, when they were finally abolished. The enforcement of these Acts had no effect apparently in controlling the prevalence of venereal diseases, the constantly sick-rate rising, as I have already said, from the low figure of 1874 to the maximum of 1884. Nor was their abolition in 1886 followed by any rise in the figure; on the other hand, the beginning of the steady fall, which I have already mentioned, coincided very nearly with that abolition. Personally I think that this conjunction was largely a matter of coincidence. It is open to others to hold a different opinion. One opinion that certainly is untenable is that the Contagious Diseases Acts had any effect on reducing the incidence of disease. On the other hand, I cannot see any causal connexion between their abolition and the reduction of disease.

The true cause in my mind of the fall in the curve is the fact that in the later eighties great efforts began to be made to render the soldier's life in barracks a more comfortable and civilized one than it had been before. At the same time the Army Temperance movement began to take hold of the man in the ranks, and as a result he began to conduct himself *si non caste caute tamen.* The improvement in the conditions of life in barracks

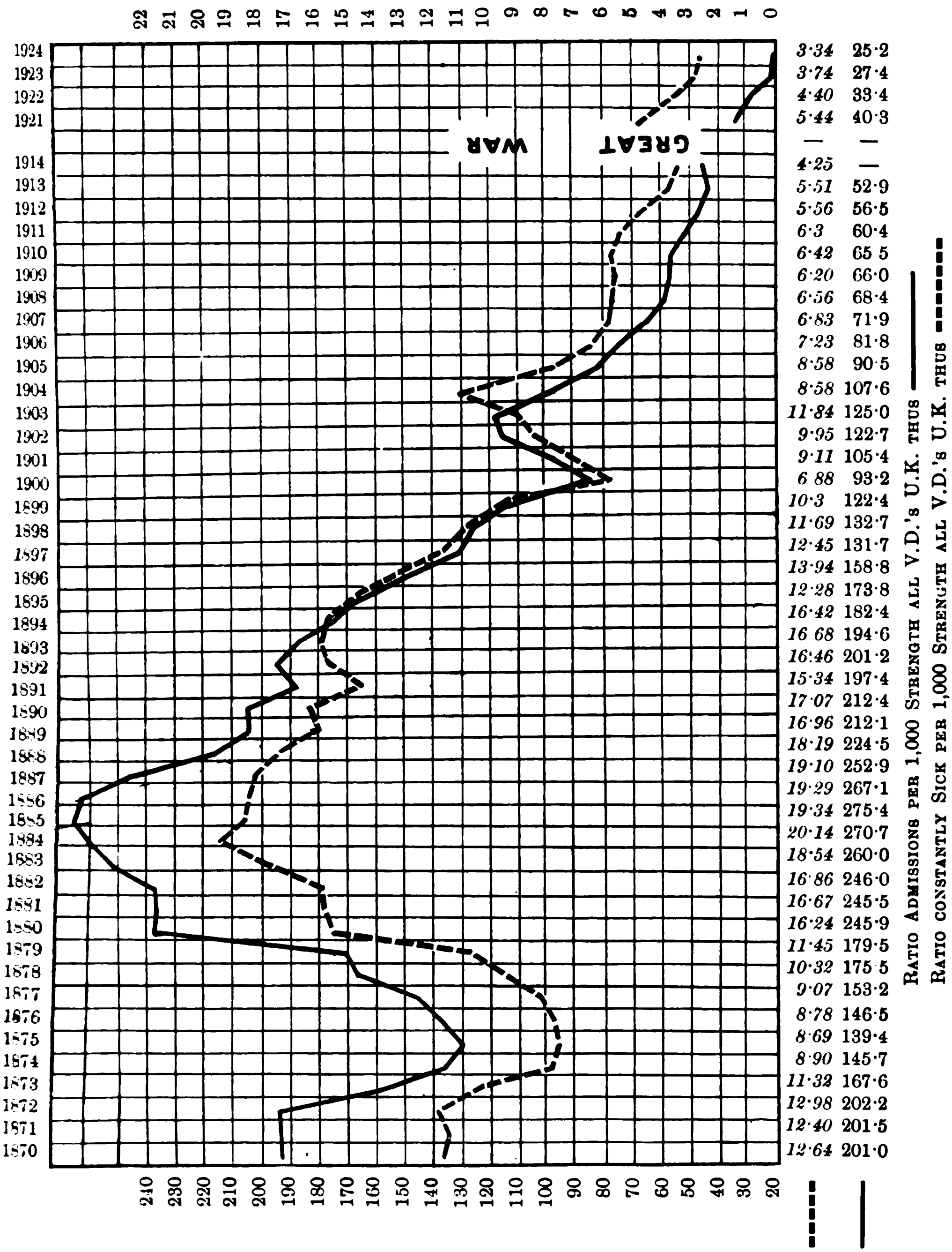
CHART SHOWING ADMISSIONS PER 1,000 OF STRENGTH AND CASE MORTALITY PER CENT FOR "ALL FEVERS" IN INDIA, 1860-1910.

Taken from "Military Hygiene and Sanitation," by C. H. Melville.



has steadily continued, and the incidence of venereal disease has declined *pari passu* with that improvement.

The only important break in the reduction of these diseases, in the years following the South African War, I attribute to the return of men who had during that war led perforce restricted lives, and to the considerable number of young soldiers who replaced the men who passed to the Reserve at its conclusion. Other causes have doubtless contributed to the reduced prevalence. The introduction of more scientific methods of treatment, especially in the matter of syphilis, with which the name of the late Colonel


22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
GREAT WAR
1924 3·34 25·2
1923 3·74 27·4
1922 4·40 33·4
1921 5·44 40·3
— —
1914 4·25 —
1913 5·51 52·9
1912 5·56 56·5
1911 6·3 60·4
1910 6·42 65 5
1909 6·20 66·0
1908 6·56 68·4
1907 6·83 71·9
1906 7·23 81·8
1905 8·58 90·5
1904 8·58 107·6
1903 11·84 125·0
1902 9·95 122·7
1901 9·11 105·4
1900 6 88 93·2
1899 10·3 122·4
1898 11·69 132·7
1897 12·45 131·7
1896 13·94 158·8
1895 12·28 173·8
1894 16·42 182·4
1893 16 68 194·6
1892 16·46 201·2
1891 15·34 197·4
1890 17·07 212·4
1889 16·96 212·1
1888 18·19 224·5
1887 19·10 252·9
1886 19·29 267·1
1885 19·34 275·4
1884 20·14 270·7
1883 18·54 260·0
1882 16·86 246·0
1881 16·67 245·5
1880 16·24 245·9
1879 11·45 179·5
1878 10·32 175 5
1877 9·07 153·2
1876 8·78 146·5
1875 8·69 139·4
1874 8·90 145·7
1873 11·32 167·6
1872 12·98 202·2
1871 12·40 201·5
1870 12·64 201·0
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20
Ratio Admissions per 1,000 Strength all V.D.'s U.K. thus
Ratio constantly Sick per 1,000 Strength all V.D.'s U.K. thus

F. J. Lambkin is honourably associated, has had a great effect. I name that officer especially, for though the methods he introduced have long been disused and replaced by others of more efficacy, nevertheless he was the first to point out that the treatment of syphilis gave just as much scope for scientific work as that of enteric fever and other diseases, and that the venereal wards were worthy of much more careful attention than was accorded them under the old routine methods of treatment, when, as a rule, they were apt to be left in charge of the last-joined officer, or those who

The ratio per 1,000 C.S. 1881-1904 has been :—

	India	*British Army O.R.s Home and Abroad*	
1881	14·75	—	
1882	17·04	—	
1883	17·31	—	
1884	18·34	—	
1885	21·43	—	
1886	24·20	—	
1887	22·95	—	
1888	25·10	—	
1889	35·55	—	
1890	36·79	—	
1891	30·16	—	
1892	29·99	—	
1893	37·49	—	
1894	43·14	—	
1895	46·14	15·28	
1896	44·87	—	
1897	46·36	—	
1898	33·67	—	
1899	27·33	—	
1900	26·92	—	
1901	23·28	—	
1902	23·63	—	
1903	22·52	—	
1904	17·62	12·49	
1905	15·37	11·08	
1906	12·32	9·35	
1907	10·61	8·66	
1908	8·08	8·85	
1909	8·52	7·62	
1910	7·79	7·50	Quinquennial
1911	7·09	7·14	period
1912	7·06	—	7·05
1913	6·90	6·23	
1914	7·29	6·07	
Great War			
1921	15·19	10·54	
1922	10·38	2·31	
1923	8·21	7·31	
1924	8·87	6·45	

displayed somewhat less attention to scientific study than their brother officers. Others have handed on the torch that Lambkin lit, and made it burn brighter, but his was the hand that did light that torch, and those of us who still remember him know how hard and uphill was the struggle.

As this is the Jubilee year of the Royal Sanitary Institute, it is but fitting that I should say something of the help the Institute has given to the medical officers of the Army in their fight against disease. The following specific instances of late date may be cited, though without pretending

that these exhaust the list. Shortly after the introduction of the Territorial scheme a course of lectures on Military Sanitation was given by the then Professor of Military Hygiene, under the auspices of the Institute, to the London Sanitary Companies, which were well attended and appreciated. Much more important are the special lectures annually given at the Institute, arranged at the request of the War Office, on Meat and Food Inspection, to officers of the Royal Army Service Corps. These lectures are accompanied by demonstrations at the meat market and other places. Officers of that Corps who had attended these courses have expressed to the present writer the extreme benefit they reaped from them.

Lastly, and most important of all, was the teaching of the men of the Sanitary Companies during the late war. I had the pleasure of having several of these in Egypt in 1916. The knowledge and the keenness displayed in fitting up demonstration centres, and supervising unskilled labour, were beyond praise. There were no more efficient units in the Force. This was a great work, and the Institute may well be proud of its achievement. But, indeed, there has always been a close touch between the Institute and the Army. The Duke of Cambridge was for many years its President, the Duke of Connaught Hon. President of the Portsmouth Congress, and Prince Arthur of Connaught Patron of that held at York. Other names similarly connected with the work of the Institute are those of Seely, Galton, Scott-Moncrief and Jones, so well known for his work at Aldershot; and, of course, many members of the Medical Service.

The movement of the Royal Army Medical College to London of course brought both the teaching staff and the pupils at the College into much closer touch with the Institute, and I gratefully acknowledge the help that I personally received in the free use that was granted to my classes of the Parkes Museum in the Institute building.

To conclude an already lengthy survey of military sanitation during the last fifty years, I will add the saying of one of the most distinguished Army Commanders in the late War. Whilst speaking to His Majesty he described the Army Medical Service as "the one department that never let us down." Such a tribute more than counterbalances the remark of Lord Wolseley quoted earlier in this paper, and it well justifies the motto of the Royal Army Medical Corps, *In Arduis Fidelis*.

The praise was given to the Corps as a whole, and in the same way the reduction of disease in the last fifty years has been the work of the Corps as a whole, not merely the work of those officers who made the prevention of disease a special study. There are, however, outstanding names which I feel I cannot omit mentioning. These outstanding names are those of Keogh, Leishman and Horrocks, worthy successors to their spiritual ancestor Parkes.

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NOTES ON AN INVESTIGATION INTO THE RELATION BETWEEN ENURESIS AND SPINA BIFIDA OCCULTA CARRIED OUT AT THE ROYAL HERBERT HOSPITAL, WOOLWICH, WITH A FOREWORD BY COLONEL J. W. WEST, C.M.G., K.H.S., CONSULTING SURGEON TO THE BRITISH ARMY.

FOREWORD.

THE steady loss of man power to the Army through invaliding from various causes requires investigation from time to time.

Recently attention was directed to the loss of men from enuresis, and it was noted that in a certain number of these cases radiological examination revealed defects in the laminæ of some of the lower lumbar and upper sacral vertebræ.

The question was raised whether this developmental defect should be regarded as an organic cause of enuresis, and to clear this up it was decided to carry out the investigation detailed below.

Lines on which the research should be conducted were laid down in a memorandum from the D.D.M.S., Eastern Command, and a series of questions was submitted by the consulting surgeon to the British Army.

The drawing up of the special case sheets necessary for the investigation was entirely the work of the staff of the Royal Herbert Hospital.

Investigations on somewhat similar lines have been carried out at other centres, and while the detailed record of the cases has not been so fully given, the general conclusions formed agree in all particulars with the findings at Woolwich.

INVESTIGATION.

The answers to the questions tabulated in Memorandum C.R.E.C. 9/9988/M(H), dated February 25, 1926, and in the Memorandum of the Consulting Surgeon, dated March 17, 1926, will be found in Appendix I.

Before proceeding to analyse the cases it may be convenient to refer briefly to various anatomical and other points connected with the subject under investigation.

ANATOMY.

The fifth lumbar vertebra has a small spine. At birth a lumbar vertebra consists of three pieces of bone, the large part forming the body and two bars of bone the two laminæ. The two laminæ are separated in the middle line posteriorly by cartilage, and from this arises the cartilaginous spine.

In the lumbar region the laminæ unite by bony fusion soon after birth, and after fusion the ossification extends into the spine.

A secondary centre appears in the tip of the spinous process at puberty, and unites with the spine at 25 years of age. It should be noted that in the cervical region the bifid tips are formed from two separate epiphyses.

The sacrum is made up of five sacral vertebræ, and on the dorsal surface are the spines of the upper four sacral vertebræ.

In the sacrum the halves of the arches unite posteriorly between the seventh and tenth years.

The capacity of the bladder in normal distension is nearly twenty ounces, but in most cases the organ is emptied when its contents reach from six to ten ounces.

The nerve supply of the bladder is derived on each side from the vesical plexus, the fibres of which come from two sources: (1) Upper lumbar nerves; (2) third and fourth sacral nerves.

Pathology.

The term spina bifida occulta is applied to a condition in which there is no protrusion of the contents of the vertebral canal, although the vertebral arches are deficient. (Thomson and Miles, Vol. II.)

Various writers point out a definite relationship between spina bifida occulta and enuresis. They state enuresis is due (*a*) to pressure from the presence of a cord, or (*b*) to a cartilaginous band running from below the epidermis in the region of the cleft to the nerve roots, or (*c*) to a hypoplasia in the structure lying below the cleft.

Classification.

It has not been possible to obtain any of the literature in which a previous classification has been laid down. An arbitrary classification has been chosen as follows:—

First Degree.—Complete absence of laminæ.

Second Degree.—Laminæ do not meet—gap.

Third Degree.—Laminæ pass each other—no fusion to form spine.

Fourth Degree.—Laminæ meet in middle line except for thin wedge of cartilage—cleft.

Fifth Degree.—Bifid appearance of spine, similar to cervical vertebræ spine (see photograph).

It should be noted here that the fourth and fifth are very minor degrees and that their inclusion or exclusion must be an important factor in the varying statistics of different observers.

It was considered desirable to take advantage of the radiological investigation and include an investigation into enuresis from a general point of view.

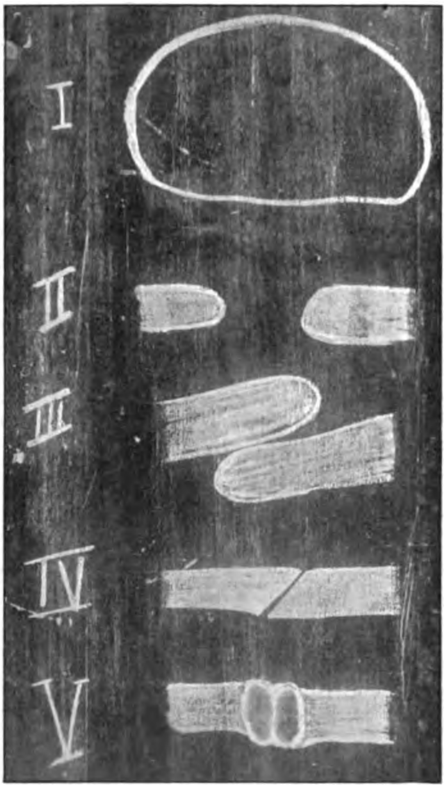
For this purpose two proformas were adopted.

That marked case sheet A (Appendix II) was for each case of enuresis admitted into hospital.

It was hoped that an analysis of a series of cases would bring forward some interesting points.

Unfortunately, as the two officers pursuing the investigation are awaiting orders for abroad, the time for the investigation has been curtailed.

In addition, the number of cases of enuresis has fallen considerably, so that since the case sheets were initiated only twelve patients have been admitted for the condition (Appendix III, A).



However, an analysis of the various headings in the light of previous experience will be attempted.

Case sheet B (Appendix III) was adopted for the particulars of cases other than enuresis cases, radiographed as part of the ordinary routine of the radiological department. These were supplemented by cases taken at random from the wards so as to bring the total of normal individuals examined up to one hundred.

Radiological Report (Appendices IV, V, VI).

Eighty-one cases of incontinence of urine were examined, and in these spina bifida occulta was found in 50·6 per cent in the various degrees

(first to fifth). It should be noted that the minor degrees, fourth and fifth, were represented by 34·6 per cent, so that in only 16 per cent of these eighty-one cases was the spina bifida occulta really "severe."

One hundred "normal" cases taken at random produced the condition of spina bifida occulta in 48 per cent, while the severer degrees were represented by 21 per cent as opposed to the 16 per cent above.

Of the hundred cases taken at random, eight cases, at present without "urinary" spmptoms, gave a history of bed-wetting.

These are analysed in Appendix VI, and it is of interest to note that five had no radiological evidence of spina bifida occulta, while in three it was present: one in second degree, one in third degree, and one in fourth degree.

The normal cases who had spina bifida and also the "bed-wetters" with spina bifida were examined for any sign of tufts of hair, skin tags or dimples in the lower lumbar and sacral regions—none such were discovered.

None of the cases showed any other signs or symptoms of any pressure on the nerve-roots in the region underlying the spinal condition.

Our conclusions on the analysis of these figures are embodied in the end of the report.

General Investigation of Cases of Enuresis.

An observation of these cases shows that the condition bears little if any relation to previous occupation, alcoholic indulgence or venereal disease.

It is noted that the majority of the cases are a "weedy" type with dull mentality, but almost invariably quite keen on games and anxious to continue serving.

As regards the amount of fluid taken daily, time of taking, etc., urinary habits, the statements are so vague and contradictory that no reliance can be placed on them.

The majority of the cases date the habit of bed-wetting from infancy.

How did they manage in Civil Life.—The majority of cases state that they carried on in civil life by sleeping on a small strip of blanket stretched out on a mackintosh sheet.

When they woke up, feeling damp, they would throw the mackintosh and blanket out of bed and sleep on a dry bed for the rest of the night.

In this connexion two cases are of particular interest.

One was a senior non-commissioned officer who had carried on for the whole of his service with this mackintosh arrangement and had actually served in the trenches, carrying this out nightly. He was sent into hospital for observation as to incontinence of urine when this failing was discovered accidentally by some keen officer.

The other case was a non-commissioned officer who had always been a "bed-wetter," but because he was a married man he had been able to carry on with his mackintosh sheet without discovery. His wife died and he had

to live in barracks. There some keen officer found he was in possession of two ground sheets. He was placed in arrest and eventually sent to hospital as a case of incontinence of urine.

Family history does not appear to have any bearing on the question of incontinence.

Cystoscopic examination does not throw any light on the condition other than the fact that a certain number appear to have a very small bladder capacity, which the Surgical Specialist (Major J. M. Rahilly, O.B.E., R.A.M.C.) is of opinion is due to faulty training during infancy and boyhood and not to developmental or pathological causes.

In the cases under observation the average daily amount of urine was normal.

Opinion.

Although the "Annual Report of Health of the Army," 1923, states that a number of cases of incontinence of urine were discharged as they had the condition of spina bifida present, it is our opinion that in the ordinary routine cases of incontinence of urine the condition of spina bifida occulta should be ignored.

We are of opinion further that on admission to hospital radiological and cystoscopic examinations should be resorted to in such cases only when there is reason to believe that a definite organic condition is present as the causal agent of enuresis.

The solution of the enuresis problem would appear to be to cease recognizing nocturnal enuresis as a disease and to regard it as an unfortunate habit.

The issue of a portion of blanket and a ground-sheet to each "bed-wetter," combined with the encouragement of the local regimental authority, would in our opinion result in cure or alleviation in many cases

APPENDIX I.

Answers to Questions.

C.R.E.C. No. 9/9988/*M* (*h*), *dated* 25.2.26.

I.

(1) What proportion of the men of the Army examined by X-rays for any cause are found to have spina bifida?

Awswer, 49·3 per cent.

(2) What relative proportions possessing this developmental disability are—

(*a*) Without urinary symptoms?

(*b*) With urinary symptoms?

Answer, (*a*) 49 per cent; (*b*) 51 per cent.

Letter from Consulting Surgeon, dated 17.3.26.

II.

(1) Number of cases of enuresis who show radiological defects of the spinal column.

Answer, 50·6 per cent.

(2) Total number of cases of enuresis who show no such evidence of defects in the spinal column.

Answer, 49·4 per cent.

(3) Total number of cases with no symptoms of enuresis who have been found on routine radiological examination to have defects in the spinal column.

Answer, 48 per cent.

APPENDIX II.

Case Sheet A. Date..........................

INVESTIGATION OF INCONTINENCE CASES FOR SPINA BIFIDA OCCULTA.

Name .... Service ....Ward ....
Rank ....Unit................ Age ....Married or Single ....

Personal History :—

Occupation prior to enlistment ....
1. Alcohol, if any, kind and amount daily ....
2. Games ....
3. Standard on leaving school..
4. Previous kidney or bladder trouble ....
5. Previous venereal disease...
6. Amount of fluid daily and when last taken...............................
7. Habit of urinating before going to bed..................................
8. Does he get up to urinate during the night? ....
9. How often does he urinate during day? ....
10. At what age did bed-wetting commence?..................................
11. How frequently now? ....
12. Is the bed-wetting getting worse?......................................
13. How did he manage in civil life? ....
14. *Family History.*
    Number of brothers ....Any bed-wetters ....
    Any familial neuroses or other stigmata ....
    Sleeping accommodation in own home, single or multiple ....

Clinical Examination.

15. Formation of genitalia : prepuce ....
16. General intelligence ....
17. Attitude towards service in the Army ....
18. Any other physical stigmata ....
19. Cystoscope examination ....
20. Capacity of bladder ....
21. Average daily amount of urine ....
    Urine................Spec. Grav...............Reaction............Alb.............
    Sugar....................Deposit.
22. Any other remarks ....
23. Radiogical examination ....

Form to be completed in duplicate and passed to Radiologist before radiological examination. Radiologist to return one copy to Medical Officer in charge of case for attachment to A.F.B. 204 or B. 178 A.

APPENDIX III.

Case Sheet B. Date......................

INVESTIGATION FOR SPINA BIFIDA OCCULTA IN NON-INCONTINENCE CASES.

Name................................ Service.............. Ward................
Rank................ Unit.................. Age........ M. or S..............

Disease.............................
Any history of bed-wetting......................
Last date of bed-wetting........................
Radiological examination........................

If spina bifida occulta present :—
General intelligence ....
Standard on leaving school......................
Any other stigmata ....
Attitude towards service in the Army...
Family history as to bed-wetting and other stigmata....................................

APPENDIX IV.

Hospital Admission for Nocturnal Enuresis.
"*Bed-wetters,*" 1925.

No spina bifida	22
Spina bifida occulta	21
Total	43

Degrees of Spina Bifida Occulta, 1925.

First	0
Second	5
Third	3
Fourth	12
Fifth	1
Total	21

"*Bed-wetters,*" 1926.

No spina bifida	18
Spina bifida occulta	20
Total	38

Degrees of Spina Bifida Occulta, 1926.

First	0
Second	2
Third	3
Fourth	11
Fifth	4
Total	20

Degrees of Spina Bifida.

Grand Total for Years 1925 *and* 1926.

First	0		No spina bifida	40
Second	7 —	8·6 per cent	Spina bifida occulta	41
Third	6 —	7·4 ,,		
Fourth	23 —	28·4 ,,		
Fifth	5 —	6·2 ,,		
Total	41 —	50·6 per cent	Total	31

APPENDIX V.

100 "*Bed-wetters.*" (Percentage taken from eighty-one cases.)

No spina bifida	49·4
Spina bifida occulta	50·6

Degrees.

First	0·0
Second	8·6
Third	7·4
Fourth	28·4
Fifth	6·0

100 "*Normal*" *Cases.*

No spina bifida	52
Spina bifida occulta	48

Degrees.

First	0
Second	10
Third	11
Fourth	22
Fifth	5

The fourth and fifth degrees are both very minor degrees, and ignoring these two degrees gives :—

First, second and third degrees spina bifida occulta { Bed-wetters .. .. 16 per cent
Normals .. .. 21 ,,

APPENDIX VI.

OF THE 100 "NORMAL" CASES TAKEN AT RANDOM, EIGHT GAVE HISTORY AS INDICATED BELOW.

Case No.	Age	Service	Bed-wetting	Last bed-wetting	Spina bifida
548	18	5 months	Once, about a month ago	—	*Nil*
1,027	24	8 years	Up to 15 years of age	Nine years ago	,,
1,029	25	6 ,,	Once, 5 weeks ago	—	,,
1,038	19	1 year 7 months	Early age on	1918	,,
1,070	21	6 weeks	Up to age of 20	—	,,
1,073	19	8 months	Once	May, 1926	2nd degree 2nd sacral
1,019	17	2½ years	As a boy	Five	4th degree 1st sacral
542	20	6 months	Up to 13 years of age	Seven years ago	3rd degree

TOXIC EFFECTS OF THE ARSENOBENZOL COMPOUNDS.

By Major P. POWER.

Royal Army Medical Corps.
Specialist in Dermatology, Poona District.

Toxic symptoms may occur in syphilis patients during or after a course of treatment with the arsenobenzol compounds.

Manifestations may be very mild when they simulate symptoms of simple intolerance to "606" or "914." On the other hand, they may be of grave significance, terminating in death.

The cause of these undesirable complications in a large number of cases is undoubtedly faulty technique in the preparation or administration of the drug in use, or indifferent examination or preparation of the patient prior to his injection.

In addition it is safer after an injection to allow the patient to do only very light work for twenty-four hours, and to make him abstain from alcohol for thirty-six hours.

Having had a wide range of experience in venereal work continuously for the past thirteen years, I classify all toxic symptoms as under:—

I. *Immediate Reactions.*—That is, reactions occurring whilst the injection is being actually given or within twenty-four hours afterwards. These may be divided into:—

(A) Headache, rigors, pyrexia, vomiting, diarrhœa or transient skin eruptions. With the exception of the last-named these symptoms are usually mild, respond to ordinary line of treatment for such conditions, and call for no further comment. The transient rashes are also mild at the time, but further treatment with the arsenobenzol group without an appropriate interval may quickly produce that grave general and skin condition, "exfoliative dermatitis."

(B) Vasomotor reactions, or the so-called "anaphylactoid shock" or "crises nitroides" of the French writers. They may be divided into:—

(1) Pulmonary symptoms when the patient suffers from dyspnœa, flushing of face and neck, sweating, dilated pupils, full bounding pulse, feeling of tightness about the chest, and occasionally swelling of the tongue and lips.

(2) Cardiac symptoms when the patient suffers from pallor, dizziness, syncope, and shock with a failing pulse. These vasomotor reactions are usually mild although often alarming at the time, the cardiac reactions being more dangerous than the pulmonary.

Treatment.—Pulmonary effects are best treated by placing patient in the sitting-up posture and giving a hypodermic injection either of

atropine $\frac{1}{50}$ grain or adrenalin hydrochloride one cubic centimetre of 1/1000 solution, the latter may be repeated four-hourly, but this is seldom necessary.

These reactions can be almost entirely prevented by the above line of treatment given five to ten minutes prior to the patient receiving his injections of the arsenical preparations.

Cardiac effects are best treated by placing the patient in the recumbent posture with head low and giving a hypodermic injection of strychnine, $\frac{1}{32}$ grain, or ether, thirty minims, or camphor $1\frac{1}{2}$ grains, dissolved in oil.

Artificial respiration may have to be resorted to in grave cases.

Desensitization of patient by administering a minute dose of the arsenical preparation half an hour before giving the larger therapeutic dose is said to prevent these vasomotor disturbances.

II. *Later Reactions.*

(A) *Stomatitis, Albuminuria, Anæmia.*—Of these stomatitis is the most common. It is usually mild, often accompanied by gradual loss of weight, anæmia and, in some cases, albuminuria. Stomatitis cases should be watched carefully as they are prone to suffer from skin reactions should the arsenical preparations be continued without a break.

The prevention of stomatitis consists in strict hygiene of the mouth from the very commencement of treatment. Old stumps should be removed and the teeth should be scaled prior to commencing an intensive course for syphilis. The patient should also cut down his smoking. If stomatitis occurs, sodium thiosulphate or thiosinamin should be administered as laid down later in this article; it has a most beneficial effect in this condition.

(B) *Symptoms involving the Central Nervous System.*—The important condition under this heading is the so-called "encephalitis hæmorrhagica" or "serous apoplexy." The former name is not a good one as in some cases after death due to this complication no hæmorrhages are found in the brain, the patient in such cases appearing to die from profound pressure on the brain substance, caused by œdema and increasing quantities of cerebro-spinal fluid being poured out. Serous apoplexy is a grave condition, usually occurring between the second and third day after treatment by the arsenobenzol group. It is most commonly seen after the second injection of the drug in use.

In this condition the patient complains of severe headache, he is irritable, temperature is raised, appetite disappears and vomiting usually occurs. He curls himself up in bed and resents being touched. He rapidly becomes worse, lapsing into a comatose condition with retention of urine and unequal pupils, later, urine and fæces may be passed involuntarily in bed. Deep reflexes at first are greatly increased, but later tend to disappear. The patient has one or more epileptiform convulsions and may die.

Treatment.—To be of any avail must be prompt, energetic and resorted to before there is irreparable damage done in the large nerve centres of the brain.

(1) Inject adrenalin hydrochloride one cubic centimetre (1 in 1,000) subcutaneously and repeat four-hourly for the first twenty-four to forty-eight hours.

(2) Perform venepuncture, withdrawing one pint of blood.

(3) Perform lumbar puncture, taking off sixteen to twenty cubic centimetres cerebro-spinal fluid. Should convulsions recur later, lumbar puncture should be repeated.

(4) Give a purgative. In a case seen by me, sodium thiosulphate was injected for this condition in addition to the above line of treatment; it appeared to aggravate the convulsions, but the patient recovered. In the majority of cases, if the above line of treatment is carried out early and energetically the patient will recover; nevertheless, his mind tends to remain confused for several months afterwards.

(C) *Liver Complications.*

(1) "Early jaundice," benign, mild, and evanescent in most cases, coming on within a fortnight after injection with one of the arsenobenzol compounds. It is sometimes preceded by a scarlatiniform or urticarial rash.

(2) "Late jaundice," the so-called "spatikterus" of the Germans, occurring weeks or months after all anti-syphilitic treatment has ceased, is usually mild in character, but may be severe.

(3) "Acute yellow atrophy of liver." This usually begins like the other two forms of jaundice mentioned, but progresses rapidly into a most grave condition, frequently ending in death. In the fatal cases there appears to be almost total destruction and disappearance of liver cells. In a fatal case, seen by me a few years ago, the whole liver had almost disappeared with gross destruction of the liver cells, but in certain areas it appeared to be regenerating itself as numerous new liver cells could be seen under the microscope.

Prevention.—These liver complications can be prevented by administering glucose, twelve drachms, and sodium bicarbonate, twenty grains, by the mouth half an hour prior to injection with "606" or "914," etc.

This procedure causes a filling up of liver cells with glycogen; these cells have then a lessened affinity for the arsenic contained in the arsenobenzol group.

For the same reason it is inadvisable to starve patients prior to their injections, as the liver cells then tend rapidly to take up arsenic when it is injected.

Treatment—Stop all arsenical and mercurial or bismuth preparations. Make the patient lie up in bed. Keep him on a carbohydrate diet with very little protein and no fat. Give mild laxatives such as rhubarb,

which may be combined with sodium bicarbonate. Sodium salicylate also appears to do good. Give large doses of glucose by the mouth, also intravenously twenty cubic centimetres of a twenty per cent solution, repeated after a couple of days' interval. Glucose is specific in the prevention and treatment of these jaundice cases.

Give "sodium thiosulphate" intraveneously. Large doses are better than small, 0·6 gramme, gradually increased to 0·9, dissolved in ten to twelve cubic centimetres of distilled water, autoclaved, strained and cooled; repeated every other day up to eight or nine injections if necessary.

"Thiosinamin" is also good, and may be used instead of sodium thiosulphate; three grains are dissolved in six cubic centimetres of distilled water, autoclaved, two minims of a two per cent solution of glycerine added and the whole injected every day or every other day in the same manner as sodium thiosulphate.

It is dangerous and most undesirable to give a general anæsthetic such as chloroform in these jaundice cases; if an anæsthetic has to be given, administer glucose by the mouth before and after the administration of the anæsthetic, otherwise fatal cases are apt to occur.

The causation of toxic jaundice is not clear. I consider more than one factor is at work; it is probably due to a combination of syphilis, arsenobenzol treatment and a catarrhal condition of the upper intestinal mucous membrane leading to an ascending cholangitis. Alcoholism appears to be a predisposing cause; when in Germany, where our soldiers got alcohol ridiculously cheap after the war, I saw over 100 cases during the three years I was Specialist in Dermatology for the Rhine Army.

It was more common during the winter months than in the warmer seasons as might be expected.

(D) *Skin Reaction.*—Toxic jaundice and dermatitis appear to have become more common in recent years, but both are now being prevented to a large extent by the administration of glucose by the mouth prior to injection.

These undesirable skin reactions vary in their intensity and, when mild, they tend to be overlooked and injections may be continued, with the result that the patient rapidly develops that severe and dangerous condition known as "exfoliative dermatitis."

Skin reactions are prone to occur in neurotic patients, also when the skin is hypersensitive, or when the skin has already been damaged by previous rashes such as eczema, etc. Cases which previously develop stomatitis or albuminuria are apt to develop skin trouble later. These rashes generally commence as a patch of erythema appearing at the site of injection, although it may appear anywhere and be rapidly followed by others which tend to coalesce. The first rash may be scarlatiniform in character, or urticarial or morbilliform. If these early rashes are overlooked and more treatment with the arsenobenzol group is given, a general

4

dermatitis rapidly follows which becomes vesicular, even pustular in places, and resembles a weeping eczema, with desquamation following; in fact, a typical "exfoliative dermatitis."

In "exfoliative dermatitis" the moist parts are always badly infected, such as the scrotal area, between the thighs, the armpits, behind the ears, and the flexures of joints.

Conjunctivæ are affected and discharge pus, there being much photophobia present at the same time, and the face becomes swollen. The mucous membranes of other parts are also involved as indicated by the cough and irritable throat, the alveoli of the lungs are very prone to become inflamed, and broncho-pneumonia is a rather common complication should the patient catch cold. The intestinal tract also becomes inflamed. The temperature is raised and in a very short period the patient is suffering from profound toxæmia and becomes seriously ill; but in the majority of cases makes a good recovery.

Treatment.—Stop all anti-syphilitic treatment. Put the patient to bed in a bright airy room. Prevent chills and keep the patient out of draughts. Nurse the case as if it were enteric fever and only allow fluids such as milk, barley water, egg flips, etc. Keep the weight of the bed-clothes off the patient by means of a cradle.

Give glucose as already recommended for liver complications; also push sodium thiosulphate or thiosinamin, as already mentioned under liver complications. Give sulphur, twenty grains, by the mouth morning and evening.

Inject three cubic centimetres of intramine intramuscularly into the buttock and repeat every fifth day up to three or four injections. Apply calamine lotion locally to the affected areas; if properly applied and allowed to dry on the skin it is better than ichthyol ointment. Later, when desquamation is taking place, bran baths are very beneficial.

Use boric lotion frequently as an eye wash, also smear sterile vaseline along the free margin of the eyelids to prevent sticking, and thus allow drainage from the conjunctival sac. Guard carefully against bed sores.

Mannite is said to be beneficial in this condition, but I have had no experience with this substance.

In conclusion, I give below a few golden rules for the administration of arsenobenzol compounds:—

Give the patient a purgative the night before.

Carefully examine the patient prior to injection.

Do not starve the patient prior to injection.

Administer glucose by the mouth prior to injection.

Test all ampoules of the drug carefully.

By preference give "914" group intramuscularly.

Use water freshly distilled and autoclaved the morning of the injections.

Give "914" group at room temperature and not warm

Have a needle which closely aud accurately fits the syringe.

Do not inject air bubbles into a vein.

Do not allow even a trace of alcohol in the needle or syringe after sterilization between injections.

Strain the solution prior to injection.

Inject into a vein very slowly.

After injection allow a trace of blood to run back into syringe.

Never inject a cloudy solution, it should have a clear golden colour.

Inject the drug as soon as possible after opening the ampoule, it becomes toxic if allowed to stand too long.

After injection only allow light work for twenty-four hours and no alcohol for thirty-six hours.

Strict aseptic methods must be enforced.

On an adjoining table place a hypodermic syringe ready and have adrenalin and strychnine to hand for use in case of need.

Editorial.

DENGUE.

THE full report of the investigations carried out by Lieutenant-Colonel J. F. Stiles, Major M. W. Hall and Major A. P. Hitchens, Medical Corps, United States Army, on the History, Epidemiology, Mechanism of Transmission, Etiology, Clinical Manifestations, Immunity and Prevention of Dengue, to which we referred in an Editorial in the June number of the Journal, has now been published in the *Philippine Journal of Science* and a short summary of the work carried out by our American colleagues may be of interest to the officers of the Corps in view of the loss of service caused by dengue in many of our garrisons overseas.

Lieutenant-Colonel Stiles and Majors Hall and Hitchens constituted the United States Army Medical Department Research Board, and they consider that their work has definitely proved that the *Aëdes ægypti* (*Aëdes argenteus* of the British Museum) mosquito is the sole transmitting agent of dengue. The earliest description of the mosquito was apparently given by Linnæus in Egypt in 1762, and he called it *Culex ægypti*.

In 1779 to 1780, three epidemics of so-called dengue occurred in widely separated parts of the globe; the first epidemic occurred in Cairo, the second in Java and the third in Philadelphia, United States. There is a possibility that the epidemics in Cairo and Java were not dengue, but the account given by Benjamin Rush of the epidemic in Philadelphia is so clear that there can be no doubt as to the identity of the disease. Later on, outbreaks of dengue attracted general attention. They occurred throughout the tropics where the conditions for the continuous breeding of *Aëdes ægypti* were favourable. The wide distribution of dengue as compared with yellow fever is attributed to the carriage of mosquitoes on ships, where in the old days water-butts were not well protected, and collections of water were the rule rather than the exception, and to the fact that twenty to thirty per cent of the cases of dengue, unlike yellow fever cases, move about and follow their ordinary avocations. Another factor favouring the distribution of dengue is the liability of cases to relapse, and on long voyages second and even third attacks were not uncommon.

Graham, in 1903, was the first to bring forward evidence of the mosquito transmission of dengue; he made his experiments in Beyrouth. The city was infested with *Culex fatigans* and *Stegomyia fasciata*, and Graham thought that the former (now called *Culex quinquefasciatus* by the American workers) was mainly implicated, but there is no doubt that stegomyia (now *Aëdes ægypti*) were amongst the mosquitoes used for producing the infection.

In 1906 Bancroft carried out transmission experiments in a dengue-infected district, and though he succeeded in causing infection by the bites of *Aëdes ægypti*, his results are not free from the objections that infection might have been acquired in other ways. He came to the conclusion that if a mosquito is the transmitting agent it must belong to a day-biting species. This rules out *Culex quinquefasciatus* and incriminates *Aëdes ægypti*.

Cleland, Bradley and McDonald made their experiments in Sydney, where dengue does not exist. They pointed out that Southern Australia is not the natural habitat of *Aëdes ægypti*, and that dengue never prevails there in endemic or epidemic proportions, whereas in the northern parts of Australia, which is the natural habitat of *Aëdes ægypti*, frequent epidemics occur. They state further that *Culex quinquefasciatus* is found throughout Australia. Five out of seven men bitten by the *Aëdes ægypti* developed the disease, but two men bitten by *Culex quinquefasciatus* were unaffected.

During 1922 there occurred in Texas a scourge of yellow fever mosquitoes (*Aëdes ægypti*), and accompanying it there was an epidemic of dengue which attacked between 500,000 and 600,000 people. Chandler and Rice studied the epidemiology of the outbreak and came to the conclusion that *Aëdes ægypti* was the mosquito primarily responsible for the epidemic.

Ashburn and Craig in 1907 showed that dengue was not contagious. Non-immune men lived in mosquito-proof huts with dengue patients, wore the underclothing of the patients, slept in the same beds, used the same utensils, but did not acquire the disease.

Ashburn and Craig demonstrated experimentally that men could be infected by the injection of blood from patients suffering from dengue. They also showed that the virus is filtrable.

Cleland, Bradley and McDonald proved that the virus is present in the serum of clotted infective blood, but they could not produce the disease by injecting washed blood corpuscles.

Koizumi, Yamaguchi and Tonomura in 1918 found that the minimum amount of infected blood required was 0·00005 cubic centimetre. But the American observers wonder whether the volunteers who received this tiny fraction of blood were protected from outside infection, as no details are given of the management of these men.

A review of the literature and epidemiological observations made by themselves and others in the Philippines convinced the Research Board that only two species of mosquitoes, *Aëdes ægypti* and *Culex quinquefasciatus*, were worthy of consideration as transmitting agents.

The experiments of the Board were planned with particular care and full details of the methods employed with regard to the breeding out and preservation of the mosquitoes, the construction of a mosquito-proof ward, and the requirements to be fulfilled by the military volunteers who offered themselves for the transmission experiments, are given in this report.

All the mosquitoes used were bred from the egg, and solutions of tap water containing slices of banana were found most suitable for the breeding of larvæ. The pH value of this solution was apparently of no great importance so long as there was sufficient alkalinity to prevent the growths of moulds. All reserve stocks of adult mosquitoes were fed on aqueous solutions of sugar.

The Board found that it was very important in experimental transmission experiments, first to produce the disease in an experimental case by the injection of blood containing the living virus, and then to transfer the virus from this source to the mosquito, so that there might be no doubt as to the date of onset. Individuals suffering from dengue are only infective to *Aëdes ægypti* during the first three days of the illness. The transmission experiments reported include 14 blood inoculations, 5 of which were positive; 111 biting experiments with *Aëdes ægypti*, 47 of which were positive, and seven biting experiments with *Culex quinquefasciatus*, none of which were positive.

The earlier experiments failed because the disease in the experimental case was more advanced than was thought at the time: too few mosquitoes were used; sufficient time was not given for the necessary development in the mosquito; or because the subjects were immune.

The experimental results obtained by the Board seem to justify the following conclusions.

Individuals with dengue fever are infective to the *Aëdes* mosquito during the first three days of the disease, but after the second day the mosquito often fails to pick up the virus. Individuals in the late prodromal stages of dengue, from six to eighteen hours prior to the onset, sometimes are infective to the mosquito.

When the female of *Aëdes ægypti* has become infected, she is capable of transmitting the virus during the remainder of her natural life.

The dengue virus must remain in the female *Aëdes* for a period of more than ten days before the insect becomes capable of transmitting it to human beings.

The virus of dengue does not pass from the infected *Aëdes* through its eggs to the next succeeding generation.

Though the Board made only seven transmission experiments with *Culex quinquefasciatus* they believe they are justified in concluding that this mosquito does not convey the virus of dengue, because the individuals were bitten without result by an adequate number of potentially infected Culex mosquitoes, and when the same individuals were bitten by *Aëdes* which had fed on the same experimentally infected patients on the same day as the Culex they all developed dengue.

The incubation period in the forty-seven successful experimental cases varied from four to ten days, and for all practical purposes it may be considered as being from four to six days.

Two strains of virus were used by the Board, one from a member of the

Board and the second strain (Collins) from a patient in the Sternberg General Hospital on the third day of disease. This strain (*c*) was transferred by subcutaneous inoculation of blood to three volunteers, and from them was obtained the strain which was used to produce experimental dengue in forty-one persons. This strain was passed from human subjects through mosquitoes and back to man for six generations of mosquitoes. The virus did not suffer attenuation by the passage, the attacks of dengue produced after the fifth passage were as severe as any observed by the Board. The clinical types produced were of every conceivable variety. The number of infected *Aëdes* used to produce dengue varied from two to thirty-six, and from two to ten were effective in fifty per cent of the positive cases. In two instances dengue was produced experimentally by the bites of two *Aëdes*.

In all experiments except one the period of preliminary observations as well as the time interval between transmission experiments was not less than eight days, and in no case exceeded eighteen days.

In 1886 McLaughlin observed in fresh and stained smears of dengue blood small round bodies about one-twentieth to one-thirtieth the diameter of a red blood-corpuscle. He thought these bodies were small micrococci and were the ætiological agents of dengue. Similar bodies are still being found in dengue blood by some workers, but they are not taken seriously now, and McLaughlin's work is purely of historical interest.

Graham, in 1904, examined more than 100 dengue patients. Blood was taken from the finger-tip and from the brightest spots of the eruptions. He stated that he found in the red blood-corpuscles an organism with amœboid movement, but differing from the *Plasmodium malariæ* in that it had no pigment. Graham fed mosquitoes on dengue patients and found the parasite in the stomach of the mosquito up to the fifth day. These observations attracted widespread attention at the time, but the bodies are now regarded as artefacts and are found frequently in the blood of normal persons.

Ashburn and Craig, in 1907, made very careful examinations of both fresh and stained preparations of blood, but were not able to confirm the results of McLaughlin or Graham. In 1919, Cleland, Bradley and McDonald examined blood with the "ultramicroscope," but did not find any evidence of a visible virus. They regarded Graham's bodies as artefacts. In 1923, Chandler and Rice made some interesting observations, their object being to demonstrate the presence of a *Leptospira*. They examined blood from dengue patients and inoculated animals by dark ground illumination and by cultural methods, which have hitherto proved successful with known species of *Leptospira*.

Their results were consistently negative, and they consider it is highly improbable that the infecting organism is of a spirochætal nature. The Board found a *Leptospira* in one case, but came to the conclusion that it had no relation to dengue. They are sceptical about the bodies figured

by Duval and Harris, especially as these observers used blood taken somewhat late in the disease.

The Board state that in tropical and subtropical countries a whole series of diseases exist clinically related to dengue. A series of cases observed in Sumatra was reported by Dutch observers under the name *Spirochætosis febrilis*. This disease has been studied by Vervoort, Van der Velt and Kouwenaar, who have cultivated from a large proportion of clinically similar cases a spiral organism, *Leptospira pyogenes,* morphologically like the *Leptospira* of Noguchi.

The cases, however, differed from dengue in that they occurred in natives and not in Europeans. The dengue rash also was absent, and jaundice frequently occurred.

In view of the reported finding by Blanchard and Le Frow of spirochætes in black-water fever by means of triple centrifugalization of the blood, the Board applied this method as the first step in the hunt for the organism. Blood was obtained from patients in the Sternberg hospital in whom dengue had occurred naturally. In the deposit from the blood when stained by Giemsa's method, spiral filaments were seen, in many cases indistinguishable from those observed in cultures of *Leptospiræ*. It was noticed, both in stained preparations and under the dark field, that there was a lack of uniformity in the individual filaments sufficient to render it improbable that they could all belong to the same species. Preparations were then made in the same manner with normal blood when the same forms were seen. These pseudo-spirochætes appear in culture tubes containing blood from patients if the medium used in cultivation is isotonic with the blood.

Connor's method of centrifuging diluted serum obtained from the blood of experimental cases of dengue was also tried, but no spiral forms were seen. In Giemsa preparations of both dengue blood and controls were seen minute deeply stained, rounded bodies, frequently surrounded by a narrow clear zone resembling a capsule. They were regarded as particles of protein which had taken on the stain.

In their cultivation experiments the Board made use of three media, the rabbit kidney ascitic fluid medium of Smith and Noguchi, the semi-solid plasma medium of Noguchi, and Vervoort's cultivation medium of 1 in 1,000 peptone, containing one to three drops of acidum phosphoricum per cubic centimetre. Blood from forty-five cases of dengue was cultured in these media, but no *Leptospiræ* were seen.

The Board consider that definite conclusions cannot be drawn from these negative results. They point out that their transmission experiments with cases of dengue occurring naturally failed, because the average duration of these experimental cases was $3\frac{9}{10}$ days, and the average duration of the natural cases admitted to hospital was only $1\frac{9}{10}$; this could only mean that they were admitted on the third day of the disease, and therefore the period during which the blood was likely to be infective had passed. The Board

intend to repeat their experiments and take blood from experimental cases during the first twenty-four hours of the illness.

Many attempts have been made to find an animal susceptible to dengue. With few exceptions investigators have reported negative results. Cleland failed with rabbits and guinea-pigs, and other observers have reported failures to infect monkeys, dogs, white mice, rabbits and guinea-pigs. The Board experimented with hogs, but without success. Koizumi and his co-workers in Formosa believed they had transmitted dengue to guinea-pigs through two passages, though subsequent attempts failed. Duval and Harris claim to have secured animal transmission, but the Board point out that their transmission experiments were made with blood at a time when the blood was not likely to be infective. They say that the appearances observed and the *microscopical* findings can be duplicated with non-dengue material.

The symptoms of cases occurring naturally, and especially of the experimental cases, are fully described. Some of them were so mild, temperature hardly raised above normal, as to render *impossible* their recognition on clinical grounds alone, yet these cases proved to be true cases of dengue when tested by means of transmission experiments. The occurrence of such cases confirms the assumption that the disease may be spread and the virus carried over periods of apparent absence by means of *missed* cases of extreme mildness. The Board believed that afebrile cases of dengue may occur even in totally unprotected individuals, and that these cases may be a considerable factor in the spread of the disease.

The immunity to infection conferred by an attack is very variable; some persons suffer from two, three or even four attacks at short intervals while others have only one wave of fever. Residents in areas where dengue is endemic maintain their apparent immunity only through unrecognized attacks, probably commencing in infancy.

Forty per cent of the cases had a saddle-back or diphasic type of fever curve; in spontaneous cases admitted to hospital the first wave is not seen owing to the patients being usually admitted too late. The Board have little hope that a vaccine or curative serum for dengue will result from the methods which have been successful in other diseases. The reasons being (*a*) that there is no solid or lasting immunity produced by an attack of dengue; (*b*) no laboratory animal is known to be susceptible to the virus; and (*c*) the etiological agent of dengue has not been discovered. The indications are that a killed virus is incapable of stimulating the production of active immunity.

Dengue can spread in a community only when there is a combination of three factors: (*a*) unscreened cases of dengue to which *Aëdes ægypti* can gain access; (*b*) *Aëdes ægypti* in such abundance that a considerable number can become infected by biting persons with dengue; and (*c*) an adequate number of susceptible persons exposed to the bites of infected Aëdes.

Aëdes ægypti is a highly domesticated mosquito. It does not hibernate and its natural habitats are tropical and sub-tropical countries: it bites between daylight and dusk, but cannot be induced to take blood when the temperature falls below 59° F. Its average duration of life is six weeks; its only breeding places are those available in and around human habitations. Oviposition is practically confined to collections of clear water; eggs are deposited not only on the surface of water, but also on the sides of the container above water level; eggs deposited on the surface of water may sink to the bottom and still hatch out; eggs will hatch after storage in a dry place for months.

Preventive measures are based on two lines of attack: co-operative effort on the part of the individual, and on well-organized mosquito control campaigns. Persons suffering from dengue should remain in bed under a mosquito net for the first three days of their illness. Non-immunes should use a mosquito net at night, and especially during the afternoon siesta. When dengue is occurring in a house every effort should be made to destroy mosquitoes by swatting, trapping, sprays, etc. Householders should see that water is not allowed to stand in uncovered receptacles for more than seven days.

In the tropics where houses are located very frequently in gardens, mosquito larvæ are found breeding in the leaf-axils of such plants as bananas and various species of the so-called elephant's ear (*Alocasia*), particularly in the dry season when the leaf-axil of such plants will retain some of the water that is daily spread over the plants; such water will serve for the breeding of *Aëdes* larvæ when otherwise no standing water is found on the premises.

In civil communities it is almost impossible to secure the co-operation of the individual, and reliance must be chiefly placed on effective control of mosquitoes, but in military stations it should be possible to secure effective control of the disease on the lines indicated.

Clinical and other Notes.

A CASE OF HYDRONEPHROSIS.

By Major C. M. FINNY, F.R.C.S.Eng.
Royal Army Medical Corps.

It is not often that a surgeon has the opportunity of observing a case of hydronephrosis from before its inception up to several years after operation for its relief; the following case therefore seems to be worth recording.

Mrs. M., aged 27, first consulted me in December, 1922, on account of pain in the left loin.

She stated that she had enjoyed good health up to about a year previously, when she sustained a blow on the left side. This was followed a few days later by an attack of severe pain in the left loin, which spontaneously disappeared after a few hours. Since then she has had several similar attacks, as well as a dull, dragging pain, after much standing. The pain has been always confined to the left renal region, and she has never had any other symptoms, or noticed anything abnormal about her urine.

The left kidney was found to be freely movable, but felt normal in size and shape.

I advised her to purchase an abdominal belt, and take exercises to strengthen the muscles.

She went home soon after, and I did not see her again until December, 1924, when I was asked to see her in consultation on account of gastric symptoms.

She informed me that on getting home she had seen a surgeon, who told her that she had a movable kidney and fitted her with a belt which had not been of much help. She still suffered from attacks of left-sided pain.

She gave birth to a child in September, 1924, and for the last six months of pregnancy had been free from the attacks, but felt a constant dragging pain in the left loin, relieved by lying down.

On November 21 she had a severe attack, accompanied by vomiting, and shortly after she noticed a swelling in the left hypochondrium, which varied in size. Since then she had been unable to go about on account of the pain and frequent vomiting.

She was given a barium meal, and the X-rays revealed a hypotonic stomach, with an elongated hour-glass constriction.

On examination in the recumbent position the contour of a tumour was plainly visible below the left costal margin. It was about the size of an orange, was smooth and tender, moved with respiration and tended to slip up under the ribs.

Operation was advised and was carried out on December 8.

The left kidney was exposed by a lumbar incision. It was very mobile, but could not be delivered from the wound on account of the renal pelvis, which was dilated to the size of a cricket ball, and was the cause of the abdominal swelling previously noticed. By applying gentle pressure to the distended pelvis urine was readily squeezed down the ureter until the swelling was small enough to permit of the kidney being delivered.

The pelvis was opened, and a long probe passed without difficulty down the ureter into the bladder.

No aberrant vessels, adhesions, or permanent kinks were found below the dilated pelvis. The size of the latter was, therefore, reduced by Israel's method of pyeloplication, and the incision in the pelvis sutured. The kidney was then fixed in position by means of stout chromic catgut. The capsule was split into four segments, which were separated towards the hilum, and rolled up so as to form a strong hold for the sutures. The upper two sutures were passed through the eleventh intercostal space, while the lower pole was suspended from the twelfth rib. The wound was closed, except for a small drainage tube, which was passed down to the kidney, and left in position for twenty-four hours. The dilated pelvis was not drained.

Once she had got over the effects of the anæsthetic the patient expressed herself as feeling much better than before the operation. The vomiting completely ceased, and she was able to enjoy her meals in a way she had not done for weeks. The abdominal tumour was seen no more; there was no leakage of urine from the tube track, and she returned to her home on December 23, with the wound healed, but was instructed to keep in bed for another week. I have seen her several times since, and on the last occasion (August, 1926) was unable to palpate any part of the left kidney.

She has been dancing and playing tennis, and seems well pleased with the result of the operation. She is completely free from all her former symptoms.

The above case raises several points of interest.

First: Was the mobility of the left kidney traumatic? Her right kidney was never palpable, and a mobile left kidney alone is comparatively rare—it occurs in about 10 per cent of all cases. So that with the definite history she gave it seems reasonable to assume that the movable kidney resulted from the injury.

Secondly: What is the connection between the mobility of the kidney and the hydronephrosis? The old view that the former is a common cause of the latter has recently fallen into disfavour. It is argued that the bending of the ureter cannot cause sufficient obstruction to produce hydronephrosis, and that the latter is a cause rather than a result of mobile kidney.

In the present case, though abnormal mobility had been evident for at

least two years, the existence of definite hydronephrosis was of recent origin. The facts that urine was easily expressed from the pelvis at operation, and that there was no obstruction to the passage of a large probe down the ureter, show that there was no organic obstruction. The complete cessation of all symptoms, after the kidney had been fixed in position, strongly favours renal mobility being the primary cause in this case; though, as Pannett[1] suggests, the immediate cause of obstruction may have been a reflex ureto-pelvic spasm.

In the matter of diagnosis—the vomiting, abdominal tumour and hour-glass stomach suggested a gastric origin for her symptoms; but her previous history, and the way in which the tumour slipped up under the ribs, indicated the organ affected.

The hour-glass appearance was due to the pressure of the hydronephrosis on the lesser curve of the stomach. In a radiogram taken after the operation this organ appeared perfectly normal.

An interesting point is the effect of pregnancy on her condition. While the intra-abdominal pressure was raised she had no symptoms, but they recurred with increased force when the birth of the child left the abdominal wall in a lax condition.

A CASE OF OPTIC NEURITIS, CAUSED PRESUMABLY BY *ANKYLOSTOMA DUODENALE* INFECTION.

By Major J. P. LITTLE.
Royal Army Medical Corps.

On September 24, 1925, Private C., aged 23, reported sick, complaining of pain and dimness of vision in the left eye. He was sent to see me the same day, and on testing the vision he was found to have vision right, $\frac{6}{24}$ left. His medical history sheet showed $\frac{6}{6}$ each eye in 1923. On examination, the left disc appeared somewhat blurred and the veins somewhat engorged; there was no measurable swelling. The right disc showed a similar condition but to a lesser degree. Both eyes were practically emmetropic. He was admitted to hospital and his blood taken for Wassermann reaction. There were no other signs or symptoms of disease. Family history was completely healthy. Occupation previous to joining the army was that of deck hand. He denied any suggestion of venereal disease. There was no history of alcohol, or lead poisoning, or of any other poison. The only entry in his medical history sheet was for a slight attack of diarrhœa three months ago. On September 27, he found on waking that he was completely blind in the left eye. Perception of light was absent, and the pupil of that eye did not react except consensually. The left disc showed marked optic neuritis of the toxic type with exudate and small hæmorrhages on and in the neighbourhood of the disc. The

[1] C A. Pannett, *British Journal of Surgery*, April, 1922.

right disc also showed definite neuritis. There was still no measurable swelling. The next day, the sight of the right eye had also completely gone. He was also complaining of severe headache and had been vomiting. Captain McVicker, R.A.M.C., Surgical Specialist, and Major Hood, R.A.M.C., D.A.D.P., were asked to see him. No localizing signs of any kind were found (X-ray of skull revealed nothing), but, in view of the headache and vomiting, in spite of the optic neuritis being of the toxic type, the possibility of tumour or cerebral abscess had to be considered. While waiting for the result of the Wassermann reaction lumbar puncture was done and the cerebro-spinal fluid was found to be under normal pressure. A specimen was sent to Poona for Wassermann reaction and the remainder examined by Major Hood, with the following result: Culture, sterile; cell-count, 60 per cubic millimetre; fluid, slightly turbid. Film: all cells small lymphocytes; no organisms. Pandy's test: increase of globulin.

Examination of blood showed: Red blood-count: 5,200,000 (normal for Ranikhet = 7,000,000). Hæmoglobin: 90 per cent. Colour index: almost 1. Total white blood-count: 8,000. Differential white blood-count: polymorphs, 64 per cent; lymphocytes, 21 per cent; hyalines, 6 per cent; eosinophiles, 7 per cent; mast cells, 1·5 per cent.

The history of diarrhœa with the absence of leucocytosis, and the eosinophilia, suggested the possibility of an amœbic abscess in the brain. The stools were accordingly searched and ova of *Ankylostoma duodenale* were found in large numbers, but no other pathogenic organism. Culture of fæces was negative to dysentry group. His blood was put up against *Bacillus shiga* and was negative. A bacillus isolated in the fæces was negative to Shiga serum (= 0 in 25). The services of Major Priest, R.A.M.C., Medical Specialist, were now available, and he examined the case without finding any possible cause for the optic neuritis.

The Wassermann reaction results were all negative as regards syphilis.

Treatment was commenced for the ankylostomiasis with 3 cubic centimetres of carbon tetrachloride, which was repeated three times, and on October 19th, 1925, his fæces were completely clear of *A. duodenale* ova. After the first dose, his stools were found to contain many ankylostomes. In the course of a month his vision began to return, though he had many relapses to almost complete blindness in each eye. After three months he could get about and could recognize people at twelve feet, but could not read any test types. Both discs showed a considerable degree of secondary atrophy. He was then boarded for invaliding to the United Kingdom. At the end of five months his vision had improved to an altogether unexpected extent, being $\frac{6}{24}$ in each eye.

I have not been able to find any record of any other case of optic neuritis due to ankylostomiasis, although Captain Mearns, R.A.M.C., D.A.D.P., P. & A. District, informs me that he has found a reference to minute hæmorrhages occuring in the meninges and brain, especially the corpus callosum, in this condition. Intestinal toxæmia is a recognized cause

of optic neuritis, and I think that, in the complete absence of any other possible cause, one is justified in attributing this case to ankylostomiasis. It is curious to note that there were no other signs of infestation with this parasite, only a very slight degree of anæmia being present, and the man himself felt in excellent health right up to the day of his attack.

I am indebted to the Officer Commanding B.S.H., Ranikhet, for permission to publish this case.

A CASE OF MELÆNA NEONATORUM.

By Major J. P. LITTLE.

Royal Army Medical Corps.

In July, 1925, Mrs. A., wife of a soldier in Ranikhet, was delivered of a healthy male child.

For the first twenty-four hours the child appeared perfectly normal, but during the first day of life there was noticed a certain amount of dark vomit on the pillow. This was followed shortly afterwards by the passage of tarry stools.

The child was given calcium lactate and observed for a period of twelve hours in the hope that the condition would resolve itself. As there was no improvement at the end of this period, on the advice of Captain McVicker, R.A.M.C., Surgical Specialist, and Major Priest, R.A.M.C., Medical Specialist, it was decided to try intravenous injections of the mother's blood.

Ten cubic centimetres of blood was withdrawn from the mother and citrated and a transverse incision of about one inch made across the child's neck in the hope of finding the external jugular vein. No vein that could take a cannula or needle could be found until the internal jugular was reached; and as it was decided that to use this vein would entail too much risk, and as, further, the child's condition precluded any longer search, the wound was closed and the child returned to the mother.

From the time of the operation the melæna ceased, except for a small quantity that had obviously occurred before the operation. While searching for the vein it was noticed that the blood did not clot at first, but within a few minutes was clotting normally. The child made an uninterrupted recovery.

The case is interesting from the fact that it opens the question as to whether the previous successes recorded have not been as much due to the trauma of injection as to the substance used—the trauma acting as a stimulus to the formation of prothrombin, which stimulus may possibly be required in these cases.

I am indebted to the officer commanding B.S.H., Ranikhet, for permission to publish this case.

A CASE OF PYREXIA OF OBSCURE ORIGIN SUCCESSFULLY TREATED BY VACCINE THERAPY.

By Captain J. A. L. WILSON.
Royal Army Medical Corps.

E. P., AGED $1\frac{1}{4}$ years, was born in Rangoon. The mother had malaria before and during the pregnancy. The child was seedy during the passage home, arriving in England in October, 1925.

The child was admitted to hospital on February 4, 1926, with a slight attack of bronchitis which cleared up quickly under treatment. It was observed that she had intermittent attacks of pyrexia at regular intervals accompanied by general peevishness, no other sign or symptom being evident.

Owing to the history and regular periods of pyrexia, blood-films were examined on several occasions, but no malarial parasites were found. Quinine, which was excreted in the urine, was given for three weeks without any change in condition. A leucocytosis of 25,000 was found on a blood-count being made.

Examination of the stools proved negative. Von Pirquet test was negative.

A pure culture of *Bacillus aerogenes* was obtained from the urine and an autogenous vaccine was prepared and given. The initial dose of 5 million, administered on April 30, was gradually increased to 50 million, no alteration in the regular periods of pyrexia occurring although the child's general condition improved and she began to put on weight after the sixth dose of vaccine.

The urine was again examined on June 16 and *Bacillus coli communior* in pure culture was recovered. An autogenous vaccine was prepared and given, commencing with a dose of 25 million. Since the second dose of 50 million no further pyrexia has appeared and the dose has now (July 20) been increased to 100 million.

The child is putting on weight rapidly and is now looking well, and no rise in temperature has taken place for last three weeks.

The striking characteristics of the case are: (1) Regularity of pyrexial periods—three-day intervals; (2) absence of any physical signs; (3) the general improvement, particularly in appearance and demeanour following the administration of the first vaccine; (4) the temperature fell to normal after the *B. coli communior* vaccine had been given.

Examination of the urine (catheter specimen), after the temperature had been normal for three weeks, showed it to be sterile.

I am indebted to Major F. Casement, D.S.O., R.A.M.C., for the bacteriological examination of the urine and the preparation of the vaccines.

Echoes of the Past.

FREDERICK THE GREAT'S CAVALRY SURGEONS.

BY MAJOR OSKAR TEICHMAN, D.S.O., M.C., T.D.
Royal Army Medical Corps (Territorial Army).

WHEN Frederick II of Prussia, surnamed "The Great," came to the throne in 1740, he found himself in possession of an army of 80,000 men, the best drilled and disciplined force in Europe, bequeathed to him by his father, Frederick William I;[1] during the first Silesian War, however, he soon discovered that his comparatively small cavalry arm, though well drilled, was no match for the mobile cavalry of Maria Theresa's army. During the years which followed, Frederick reorganized his mounted troops and eventually during the Seven Years War made them the finest mounted corps in Europe. In 1755 he published his "Regulations for the Prussian Cavalry," dictating the contents word by word, and it is from this book that the author has extracted his information about the medical services of the cavalry regiments.

(1) ESTABLISHMENTS.

A Regiment of Horse (Cuirassiers) was composed of five squadrons divided into ten troops, the total effective strength of officers and other ranks being 848.

One surgeon was appointed to the unit, and under him were five surgeon's mates, one to each squadron; in addition five "servants," one per squadron, were allowed to attend the sick. The surgeon's mates must have had a busy time as, in addition to their medical duties, they were responsible for the shaving of some 160 men each.

A surgeon received 69 dollars a month and forage for two horses, but out of this he was expected to contribute a certain amount towards medicine for the men, although 100 dollars was specially allowed to each regiment for that purpose. A mate received 6 dollars a month.

The medical personnel of a Regiment of Dragoons was identical with that of a horse unit.

A Regiment of Hussars was a much larger unit, consisting of ten squadrons, the total effective strength being 1,172.

Eleven medical officers were attached to the regiment, a surgeon-major

[1] *Cavalry Journal*, January, 1926.

and ten surgeons; of the latter one was appointed to each squadron: in addition there were the ten servants "to attend the sick."

Frederick realized that as Hussar squadrons often acted independently for considerable periods it was essential that they should each have a qualified surgeon in medical charge and not only a surgeon's mate.

It is not stated whether the surgeons of Hussar Regiments were expected to perform all the duties of mates in other regiments, i.e., shave the men of their respective squadrons and attend to the cutting and queuing of their hair!

A surgeon-major of Hussars received 84 dollars a month, and forage for four horses; he, like his Dragoon colleague, was expected to contribute towards medicine for the men, but was also allowed over 100 dollars specially for that purpose.

Each regiment had its own medicine chest, which the regimental surgeon-major, or surgeon, kept stocked by means of the money granted for that purpose. On no account were these officers allowed to replenish their stores from the hospital medicine chest.

(2) Appointment and Choice of Surgeons.

The following are the instructions issued by Frederick. "No Surgeon Major (or Surgeon) shall be taken into the Army, till he has been presented to the Surgeon General, and examined by the Professors of the College of Physicians and Surgeons, that his Majesty may be assured, there is no Surgeon Major (or Surgeon) appointed to any Regiment, who has not acquired a proper experience and understanding of all kinds of diseases; to certify which, the Professors, after he has been examined, are to give him an attestation, setting forth his abilities; and if it appear from these, that he is properly qualified, the Solicitor is then to administer to him the Oath of allegiance, in the presence of the Commanding Officer.

"The Mates belonging to every Regiment, shall be appointed, subsisted, and dismissed by the Surgeon Major, and be also subject to his authority; they are likewise to swear allegiance to the Regiment for the space of time which their contract with the Surgeon Major is to last: that they will serve faithfully, attend the sick and wounded diligently, and submit altogether to the subordination of the Regiment.

"The Surgeon Major shall be answerable that he admits no Mates, but such as are capable of the employment; and particularly careful to appoint those only to Squadrons which lie alone in garrison, who are well skilled in all kinds of disorders; in like manner, when a command is sent out, the same caution is to be observed: such sick men as labour under dangerous and chronic diseases must, if practicable, be removed to headquarters where the Surgeon is. Every Captain must remain satisfied with his mate, provided that his Troop or Squadron is shaved at the proper time, that his sick and wounded are taken good care of, that he keeps himself in due sub-

ordination, and does his duty diligently; in default of which, he must be reported to the Commanding Officer of the Regiment, and to the Surgeon Major, in order to be punished."

(3) Care of the Sick and Wounded on Active Service.

When a unit or units were in camp, the senior surgeon was instructed to appropriate a suitable building in the nearest town as a general hospital, to which sick and wounded men were evacuated; this hospital was staffed, when necessary, by 8 surgeons and some N.C.O.'s who were in charge of the men's subsistence money and the hospital medicine chest. As there appeared to be some risk of regimental surgeons leaving their units (possibly when an action was impending!) and gravitating towards the hospital, Frederick, in his regulations, very wisely adds the following note:—

"N.B.—As it is his Majesty's pleasure that only eight Surgeons should constantly remain with the medicine chest, so every other Surgeon is to return to his Regiment after he has lodged his sick in hospital."

An order relating to medical stores states that—

"When the Army is in a standing camp the medicine chest must be kept at the hospital, and no medicines are to be given out of it to the Surgeon Majors of Regiments: but his Majesty will allow 112 dollars to every Surgeon Major for medicines for the whole Regiment; with which he is to provide all kinds of necessary medicines, for such sick men, as are not sent to the general hospital; and that no surgeon may be suffered to want his proper quantities, a Physician and the Surgeon General of the Army, shall, about once every month, visit the Regimental medicine chests; for which reason the Surgeon General, and a Physician are to attend the Army constantly."

Sick and wounded men on the march were carried in wagons (provided for that purpose) until the unit reached a standing camp again, when they were evacuated to hospital. Troopers who were only slightly sick and those whose horses were lame were ordered to march with the medicine chest—"Nor shall any sick man be suffered to do duty, till he is perfectly recovered for fear of a relapse."

Squadron leaders were ordered to furnish eight blankets for the use of their sick, and to see that good broths were made for them, and everything else necessary.

The men of every tent were compelled to join their pay and mess together.

"Nothing contributes so much to the preservation of the soldiery, as the eating of warm victuals every day, for which reason, when they cannot provide otherwise for themselves, they must eat their ammunition bread boiled up in water, with some salt in it, and the Captains and Commanding Officers of Regiments shall be answerable, that their men keep a good mess, and make the pot boil constantly once a day."

Very little is said about the duties of the surgeons in action, but it was apparently necessary to remind them of their *raison d'être!*

"The Surgeon's Mates are always to attend their respective Squadrons on the march, that in case of sudden accidents, they may be at hand to apply the proper remedies; and their attendance is more particularly required when the Regiment is in action. The Surgeon Major must also be present, when his Regiment is in action."

(4) Care of the Sick in Garrison.

In every garrison town there was a general hospital staffed by the medical personnel of a unit or units.

In a hospital for one regiment, one mate and two servants were in charge, a field officer and surgeon or surgeon-major paying daily visits.

It was also laid down that:—

"When any dangerous disease breaks out in a garrison, the Surgeon Major, and more especially the Mates in his absence, must consult with a physician, if there happen to be one in the town, in order to put a stop to it, if possible, in its infancy, and prevent its spreading; to contribute to which every sick person in an hospital seized with an infectious disease must be immediately removed.

"When a Captain employs a doctor or any other person out of the Regiment, to care a sick man, the Surgeon Major shall not be obliged to furnish the Medicines. When a Troop, or Squadron, has a great many sick, the Surgeon Major must attend it in person."

(5) Preservation of the Soldiery in General.

Troopers were encouraged to report sick if they felt at all indisposed, "since some diseases may be prevented from becoming epidemical if they are not too long concealed." For this reason officers were ordered to constantly observe the looks of their men and send them to hospital at once if they appeared to look out of sorts.

Self-medication was forbidden: "No Officer, non-commissioned officer, or Soldier, before a march or at any time in the spring, shall, by way of prevention, physic himself without the Surgeon's knowledge and approbation."

Men were forbidden to squander their pay on fruit during the fruit season, "as this throws them into distempers," and were advised to spend it on bread instead.

Excessive drinking was forbidden and a special regulation forbade men to drink anything at all when they were hot. "So the Officers are by no means to suffer their men to drink on a march in hot weather; for the same reason the troops or squadrons, after they have been performing their march on foot, must be detained for some time under arms before they are dismissed; a general order ought also to be given to refrain the men from

drinking too soon after all violent exercises. Moreover, as it is unwholesome for a man to come suddenly out of a hot room into the cold air, so the fires in the guard rooms, and in quarters, shall not be made too large."

(6) Of Camp Utensils.

These appear to have been of two kinds, and the short chapter on them is given herewith:—

Article 1.—"Every Troop of Horse shall be supplied with fifteen camp kettles, fifteen canteens and hatchets, and every Squadron of Dragoons with double the number of each, when they take the field, which, together with all camp necessaries, must be taken good care of both on a march and in camp. The kettles must be kept clean in linen bags.

Article 2.—"No Whores shall be suffered to stay in camp. When anyone therefore comes into a Regiment, the Colonel or Commanding Officer must order her to be stripped naked and turned out. The General Officers likewise are not to allow any Whores to remain at headquarters, much less any Whore-Tents to be pitched, to prevent which the Solicitor is required to be very careful."

No doubt some form of A.M.S. Regulations was in force in Frederick the Great's Army, but the above extracts from his orders to Cavalry M.O.'s are of interest because they emanated direct from him.

(From Regulations for the Prussian Cavalry by the King, 1755; translated into English by Captain Faucit of the Guards, 1757, and dedicated to the Earl of Albemarle.)

Current Literature.

A Preliminary Note on the Control of Reactions following the Administration of Drugs and Vaccines. In a paper read before the Malayan Branch of the British Medical Association in Singapore on July 26, 1926, Lieutenant-Colonel Hope Falkner states that in the treatment arsenical dermatitis injections of Boots' thiostabon thiosulphate, 0·9 gramme daily, caused great improvement, the local lesions clearing up. The vasomotor reactions were relieved by subcutaneous injection of 3-5 minims of 1-2000 adrenalin chloride. When the patient complained of cardiac discomfort the adrenalin was stopped and atropine sulphate substituted. Novalgen was also found useful.

In the control of anaphylactic reactions following "2 and 4" given intravenously, Lieutenant-Colonel Falkner considers adrenalin chloride to be very efficacious. He has also found that three minims of adrenalin chloride (1-2000) when mixed with one cubic centimetre of cholera vaccine

prevented the constitutional reactions produced by the vaccine alone and limited the local reaction. The value of the vaccine thus administered did not appear to be affected.

PRISTON, J. L. **The Prevention of Scurvy in the Navy. With Appendix.** *Journ. Roy. Nav. Med. Serv.*, 1926, v. 12, 1-20 [45 refs.]. Also in *Proc. Roy. Soc. Med.* (War Sec.), 1926, v. 19, 7-12.

The author reviews the history of scurvy in the Navy, recalling how the incidence decreased after the introduction of the use of lemon juice in 1797 and increased again when lime juice was substituted soon after 1860. Since 1918 reliance has been placed upon a plentiful supply of fresh fruit and vegetables. Under peace conditions there is no difficulty in ensuring a sufficient supply of fresh meat and vegetables, but under war conditions, particularly in tropical waters, there would probably be great difficulty, and the problem of providing an efficient antiscorbutic might become an urgent one.

At present the only reliable sources of antiscorbutic vitamin for crews which cannot obtain fresh food are germinated marrowfat peas and haricot beans. The germination is not a very simple operation, and each man would need to eat half-a-pound of the germinated food daily. The issue of tinned tomatoes as part of the Naval ration has been recommended ; if care were taken in the choice of the fruit and the mode of tinning, probably 3 oz. per man daily would suffice to prevent scurvy, but even this amount would prove very bulky for storing and many men would probably not eat their ration.

Many workers have in recent years succeeded in preparing concentrated extracts of lemon juice which retain to a large extent their antiscorbutic value. Some of these are unpalatable, some are very expensive to prepare, and most of them lose their potency when kept for any length of time, particularly at temperatures which might be expected in the tropics. The author has recently been making experiments with a concentrated orange juice manufactured by the Exchange Orange Products Co., of San Dimas, California, and marketed in England by the proprietors of Glaxo. Experiments with guinea-pigs showed that when not more than a few months old this preparation had at least three times the antiscorbutic potency of fresh orange or lemon juice ; after storage at about 8° C. for a year its potency was double that of orange juice; after 42 weeks at 19° C. it was roughly equal to that of orange juice, while during 19 weeks at 37° C. it lost all its potency. Addition of rum to the preparation did not increase its keeping power. The author calculates that 5 c.c. of this preparation a day would suffice to protect a man against scurvy, so that a sufficient supply for a three months' cruise could easily be carried in a ship's cold storage. Bacteria and moulds do not grow in the concentrated juice. It is estimated that £4,000 per year would be saved by substituting the active concentrated preparation for the "useless" lime juice at present issued.

The Appendix describes a method of using peas or other pulses for the prevention of scurvy in the absence of fresh vegetables; it is modified from a paper by Miss CHICK and Miss HUME (*J. Roy. Army Med. Corps*, 1917, v. 29). The peas, etc., should be placed in a large clean sack and steeped in clean water for six to twenty-four hours, depending on the temperature. They must then be spread out to a depth not exceeding two inches in vessels with porous or well perforated sides and bottom, covered with a cloth which must be kept damp, and allowed to germinate for 24 to 48 hours. They should be eaten as soon as possible after germination, without being allowed to dry, and they must not be cooked for more than half-an-hour. E. MELLANBY.

Reprinted from "Bulletin of Hygiene," Vol. 1. No. 5, 1926.

SUPPLEE, G. C. & DOW, O. D. **Variations in the Antiscorbutic Properties of Dry Milk.** *Amer. Journ. Dis. Children.* 1926, v. 31, 41-50, 7 figs. [14 refs.]

The antiscorbutic properties of fresh cow's milk, as measured by its power to protect guinea-pigs from scurvy, have been shown to vary considerably according to the season of the year and the diet of the cow at the time the milk is being tested. In the case of dried milk the same factors would operate to cause a variation in the antiscorbutic potency of different samples, but in addition there is evidence that the method of drying the milk itself affects the potency. Many observers claim to have shown that milk dried by the Just roller process retains its antiscorbutic vitamin better than that prepared by the spray process. On the other hand, other workers have concluded that the spray process causes no loss of antiscorbutic potency.

The authors of this paper set out to clear up this disputed point. They fed groups of guinea-pigs with two distinct basal rations and found that the addition to either of as much as 80 c.c. of reconstituted spray process milk per diem was insufficient to protect the animals from scurvy. On the other hand, dry milk made by the Just roller process and stored in air at room temperature for two years still had an antiscorbutic potency roughly equivalent to that reported for fresh milk produced at the same time of the year; frequently 60 c.c. and always 80 c.c. of this reconstituted product sufficed to protect the animals from scurvy.

E. MELLANBY.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 5, 1926.

JONES, D. B. **The Chemistry of Proteins and its Relation to Nutrition.** *Amer. Journ. Pub. Health*, 1925, v. 15, 953-7. [1 ref.]

Modern advances in the science of nutrition have been emphasizing the importance of the quality of individual foodstuffs in a diet. The same principle applies to the protein fraction of a diet. It has long been known

that certain proteins lack essential amino acids and therefore are incapable of supporting life when given to animals as the sole source of protein in their food. Zein, which lacks tryptophane, is one of the best examples. It has been found by the author that the proteins of the common white navy bean will not induce growth in young animals when given as the sole source of protein in an otherwise adequate diet. The addition of 0·2 to 0·3 per cent of cystine enables the animals to grow slowly. If the proteins are heated before they are given and cystine is added at the same time the young animals grow at a normal rate. These particular proteins contain more than twice as much cystine as does casein, which produces quite satisfactory growth as the sole source of protein in a diet. It would appear that for some reason as yet unknown the cystine of this bean protein is not "available," particularly when the protein is eaten uncooked.

Three proteins have been isolated from wheat bran; they contain much larger amounts of the indispensable amino-acids, especially lysine, trytophane and cystine, than do proteins of the wheat endosperm which are found in white flour. Young rats fed on a diet containing abundant supplies of vitamins A and B and bran as the sole source of protein grew much better than those fed on wheat endosperm with the same amounts of vitamins. The prevalent idea that bran has no real food value except for ruminant animals has therefore no foundation in fact.

E. MELLANBY.

Reprinted from "Bulletin of Hygiene," Vol. 1, *No.* 5, 1926.

AMSTERDAM. September, 1925. 4de Internat. Congres v. ongevallengeneesk. en beroepsziekten. Verzameling der voordrachten in de plenaire Zittingen. [**Fourth International Congress on Industrial Medicine and Hygiene.** 13 papers.] 125 pp. Uitgave van het *Nederlandsch Tijdschrift voor Geneeskunde.*

i. SAUERBRUCH, F. Geschwulst und Trauma. [**Tumours and Trauma.**] *Ibid.*, pp. 11-18.

A review is given of the present-day attitude towards this difficult question. It is generally admitted that, at the most, trauma can only be a contributory factor towards the formation of a neoplasm in a person who is already predisposed in this direction; what the primary predisposing factors are is up to the present unknown.

Even experimental mouse carcinomata, which are produced by painting a small area of skin with tar over a long period, according to Sauerbruch, only occur when the animal is already chronically poisoned by the tar absorbed into the system; a *general* disturbance has been introduced, before the *local* factor comes into play.

Certain *non-malignant* neoplasms have always been definitely associated with a traumatic factor. The more important are: (*a*) *Keloid*, a connective tissue growth which only occurs in scars, viz., after trauma to the skin

Even the so-called spontaneous keloid arises only after minute, perhaps unnoticed, interruptions in the continuity of the skin; and (*b*) *Xanthoma*, also a post-traumatic connective tissue overgrowth which occurs in tendons, periosteum and synovial membranes, but only in patients who have a definite disturbance of metabolism, viz., cholesteræmia. This is a good example of the importance of the general factor.

When we come to *malignant* neoplasms, the connexion between trauma and tumour is very uncertain. Accounts on this subject are usually unreliable and fantastic ("eine Sammlung von Anekdoten"), especially if they are based on the statements of patients; the latter are notoriously prone to exaggerate a traumatic factor. The percentages of malignant tumours due to blows and injuries are variously given as anything between 50 per cent and 0·9 per cent; the latter figure is probably nearer the mark. Many pathologists refuse to allow the trauma factor any influence at all. Yet, clinically, we now and again come across cases where it is impossible to deny a connexion.

Two very striking examples of this are given: (1) a case of sarcoma of the ulna after a severe blow on the forearm; and (2) a case of sarcoma of the kidney which arose as the result of a blow in the flank. An important point is that both cases had localized hæmorrhages at the time, and this showed itself by hæmaturia in No. 2. In both cases the symptoms caused by the neoplasm began about three months after the injury, the patients being quite well in the interval.

Speaking generally, a blow may produce a sarcoma, while prolonged slight trauma is more likely to cause a carcinoma. Well-known examples of this are lip cancer and and pipe smoking, epithelioma of the scrotum in chimney-sweeps, bladder epithelioma after Bilharzia infection, but more particularly X-ray cancer.

In spite of these well-known instances the position is by no means always clear, especially when a decision has to be given in a court of law Certain rules for guidance have been laid down by Thieme and Lubarsch and are useful to remember.

(1) It must be proved that a true tumour is present, also that trauma was really suffered and of a kind likely to produce such a result; (2) the tumour must develop in the region which has been damaged by the trauma; tumours at a distance from the alleged blow cannot be admitted; (3) the time interval between trauma and the development of the tumour must not be too long; for sarcomata any time between 3 weeks and 2 years may be allowed; for carcinomata the interval averages $2\frac{3}{4}$ years; (4) histologically the tumour must be compatible with the trauma inflicted; if localized hæmorrhage can be proved this is particularly useful.

E. L. Collis.

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Reviews.

JUBILEE RETROSPECT OF THE ROYAL SANITARY INSTITUTE, 1876-1926. Compiled by Louis C. Parkes, M.D., D.P.H. London: Offices of the Institute. 1926. Pp. viii + 119, with 38 illustrations and one map.

The Royal Sanitary Institute, with which is associated the Parkes' Museum of Hygiene, celebrated its Jubilee this year, and, although it came into being after his death in 1876, a great part of the inspiration that led to its formation emanated from our first Professor of Military Hygiene, Dr. Edmund Parkes. The Retrospect now issued to celebrate its Jubilee contains an interesting and detailed account of its origin and development. Dr. Parkes is given the premier place in the distinguished list of pioneers and Chairmen of Council, whose biographies are recorded, and whose photographs appear in the first part of the volume. We find the names of more than one well-known officer of the Army Medical Service, such as Professor de Chaumont, Sir Thomas Crawford, and Colonel Lane Notter, in the list of Chairmen of Council, a position which they shared with others whose names are household words in the history and development of public health work and administration in Great Britain. One of the chief objects of the Institute, apart from meetings and discussions of scientific papers, has been the examining and granting certificates of qualification to surveyors of sanitary districts and inspectors of nuisances; and it is to these that much of the high esteem in which British sanitation is held throughout the world can be traced. Since its foundation 2,555 examinations have been held, including 453 in British possessions overseas. The number of candidates reached a total of 37,623, of whom 54·3 per cent passed the examinations in the British Isles, and 45·5 per cent in India, the Dominions and Colonies. The certificates now include qualification in such subjects as child welfare, health visiting, school hygiene, sanitary science, and tropical hygiene, in addition to sanitary inspection subjects and surveying. The subjects which were taken up most by the candidates were sanitary inspection, health visiting, school hygiene and sanitary science. The highest percentage of passes in these was 70·1 in school hygiene.

The Retrospect also gives an account of the other activities of the Institute, a list of the congresses and conferences held by it in different parts of the Empire, its war services, a description, with photographs, of its present premises, its Journal and publications, and other details of interest. The number of its fellows and associates forty years ago was 387; it is now 4,630.

The remainder of the volume contains a series of articles of much

historical interest on sanitary progress during the last fifty years. Professor Bostock Hill writes on the Medical Aspect, Mr. Percy Boulnois on Sanitary Engineering, Sir Henry Tanner on the Architectural Aspect, Mr. MacMorran, K.C., on the Parliamentary and Legal Aspect, Sir William Collins on Public Administration, the Hon. Sir John Cockburn on the Overseas Dominions and Colonial Aspect, Colonel C. H. Melville on Military Hygiene and Sanitation, and Fleet Surgeon W. E. Home on Sanitary Advance at Sea. These articles constitute a record of sanitary progress which it will be hard to beat, each in itself being a wonderfully clear and concise retrospect of the aspect of sanitary progress with which it deals. The frontispiece of the volume is a fine photograph of the Minister of Health, who presided at the Congress of the Institute, held in London this year: and the contents worthily record the far-reaching and important activities of an Institute which has carried on its work quietly and modestly during the last fifty years.

THE CANCER REVIEW: VOLUME I, NOS. 1 AND 2. Bristol: Wright and Sons. 1926. No. 1, pp. vii + 80; No. 2, pp. viii + 72. Price 3s. 6d. each number.

At the end of last year, the Council of the British Empire Cancer Campaign, of which Sir John Goodwin is the organizing adviser, in order to bring together the information published in general medical journals and those dealing with the numerous subjects of medicine, surgery and other branches of biology, considered it advisable to issue a journal of abstracts of the results obtained by the host of trained and competent observers engaged in studying from the various points of view the problems of tumour formation in general and of malignant new growths in particular. An Editorial Committee of ten well-known workers in pathological, surgical, chemical and statistical research was appointed, and Dr. F. Caver, who had already initiated a journal of ecology, was appointed general editor. The object of the Council has so far been attained in the issue of the first two numbers, in July and August of this year; and, if we may judge by their contents, the "Cancer Review" has come to stay and will prove of pre-eminent value to the scientific world and medical profession generally. The abstracts, which are short and to the point, contain the essential points of all that is being published on the subject of cancer in contemporary British and foreign medical literature. They are excellently arranged under five different headings: general, experimental and bio-chemical, clinical and pathological, radiological, and statistical. The subject of each abstract is shown in the list of contents, and a list of authors is given with the page index. Further, each abstract has the name of the member of the editorial committee responsible for it added to it. The abstracts are numbered consecutively and some idea of their extent and variety may be gathered from the fact that there are 268 in these two

first numbers of the Review. The Review is well and clearly printed, the writing and translations from foreign literature leave nothing to be desired, and there is little left for us to say beyond offering our congratulations to the general editor and his committee and wishing the Review the success which it so richly deserves. The numbers, we understand, are to appear monthly, with the exception of two months of the year, and the ten annual numbers may be obtained on a subscription of 30s. Agents for its sale have been appointed in London, Toronto, Calcutta, Bombay, Sydney, New Zealand and New York. We may mention also that our late Director-General, Sir William Leishman, was one of the moving spirits in instituting this Review.

Lipatren in the Treatment of Tuberculosis. Behringwerke-Mitteilungen No. V. Marburg: Lahn. 1926.

In the correspondence circle, No. VIII, of the September (1925) number of the Journal of the Royal Army Medical Corps, Dr. Andrew Balfour, in an account of research in the commoner tropical diseases, refers to the use of yatren, a combination of iodine with oxyquinoline sulphonic acid, in the treatment of amœbic dysentery. The directors of the Behring Chemical Works, which produced this preparation, have combined it with a non-specific lipoid, obtained from calf's brains, under the name of lipatren, and claim it to be a valuable therapeutic agent in the treatment of tuberculosis. Apparently it has been used for this purpose during the past two or three years, with a considerable amount of success on the Continent, notably by Dr. Gustav Maurer, the director of the Guardaval-Davos Sanatorium, and by Dr. F. Mattausch, of Vienna. The pamphlet now issued by the Behringwerke contains a summary of the rationale of the lipatren treatment, the rules to be followed in the selection of cases, and the determination of dosage. The principle underlying the combination of a lipoid with a chemical substance, such as yatren, is that the lipoid acts as a non-specific stimulant to the natural efforts of the body to destroy the disease germs; in other words, as an antigen stimulant, in contra-distinction to treatment by specific antitoxins. Over-stimulation, however, is harmful, and the dosage is consequently of fundamental importance. Only small quantities should be given to commence with, and the effects carefully watched by observation of the temperature, blood examination, and symptoms of reaction, either general or restricted to the seat of the disease. The drug can be administered by intramuscular injection or in the form of tablets, by the mouth; but good results are likely to be obtained only by accurate gauging of the dosage according to the state of each individual case. Articles by Maurer in Vol. LXIV of the *Beiträge zur Klinik der Tuberkulose*, and by Mattausch in No. 36 of the 1926 volume of the *Medizinische Klinik*, record several clinical cases in which lipatren has been administered. The whole subject, including a critical study of these cases, seems worthy of serious attention, as it appears to

open up a form of treatment of tuberculosis which may prove ultimately of value, but which, from all we can gather, must be applied with great care.

MIND AND ITS DISORDERS. By W. M. B. Stoddart, M.D., F.R.C.P. London: H. K. Lewis and Co., Ltd. 1926. Pp. xx + 593. Price 21s.

The fifth edition of this well-known book has been published, and presents a thoroughly revised version.

The author continues to approach the subject of mental diseases from a purely psychological standpoint, without, however, losing sight of other methods of research into mental processes.

The first part of the book is a fairly full digest of normal psychology, and the second deals with the psychology of the insane, while Part III is devoted to mental diseases. The nomenclature used is similar to that of the previous edition, save that the author now includes neurasthenia under the general heading of the psycho-neuroses instead of the neuroses. He has apparently satisfied himself that neurasthenia is due to partially forgotten or completely forgotten situations, incidents, or phantasies of childhood as opposed to those ætiological factors in the present or comparatively recent life of the patient which form the starting point of the neuroses.

Thus, " neurasthenia " is defined as a disorder which makes its appearance in early adult life, and is chiefly characterized by an increased susceptibility to fatigue on slight exertion, mental or physical. The author insists that neurasthenia is a definite disease entity, and not a "rubbish heap," thereby admitting that the "rubbish heap" exists, but he agrees that it is extraordinarily difficult to place certain cases in any definite category.

The bases of the neuroses, psychoneuroses, and psychoses are all supposed to be psychical, such morbid anatomical changes as have been described being regarded as "secondary." The psychotic patient usually fails to recognize his infirmity, and is therefore unable to adapt himself to his environment, while the patient suffering from a neurosis or psychoneurosis is conscious of his disability.

Of the psychoses, the author holds that the manic depressive disturbance differs from the others, in that it is not narcissistic, the mental conflict lying rather between the ego and the ego ideal, or super ego.

Although this disease is always accompanied by physical signs, no physical *basis* for the disease has ever been demonstrated. The psycho-analysis of such patients in the intervals between their attacks shows, the psycho-analysist claims, that melancholia is the original phase of the psychosis, erected on a basis of repressed sado-masochism, i.e., the patient in infancy conceives an unconscious hatred of someone (a near relation) whom he

ought to have loved, and perhaps did love consciously. There follows an unconscious desire to punish this person, and, by introjection, the reproaches are directed against his own ego by his ego ideal. Such a theory certainly explains the sado-masochistic state of self-punishment and self-reproach, the delusions of unworthiness and wickedness, and suicide; but hardly explains the frequent hereditary factor observed.

In ordinary dementia præcox no psychological factor is postulated as a cause, although Jung claims an exclusively psychical origin of this disorder. Reference is made to the frequent recurrence of the disease in an insane stock, the physical change discovered by various observers is mentioned, and for this disease the conclusion is reached that some active morbid physiological process is probably at work.

Under the treatment of general paralysis the author now omits a description of the manifold methods of intrathecal medication, but describes in some detail the more recent and successful treatments by tryparsamide, and by the inoculation of malaria. No book on mental diseases is complete without reference to encephalitis lethargica, and a chapter on this disease is now included.

If mental disorders can be viewed mainly from a psychological standpoint, we have every encouragement in this book that by psycho-analysis such can be cured, but we feel that the physical and physiological aspects of the disorders are not given due consideration, and unless the three general ætiological factors are properly balanced the causation of mental disorders remains difficult and obscure, especially when patients have to be handled in everyday practical life.

The chapter on mental disorders associated with primary disease of the endocrine organs is useful, as also is the portion on toxic insanity, where it is a relief to find a definite concrete cause in which one can believe.

The general get up of the book is excellent. W. L. W.

HINTS TO PROBATIONER NURSES IN MENTAL HOSPTALS. By Richard Eager, O.B.E., M.D. London: H. K. Lewis, Ltd., 1926. Pp. 88. Price 1s. 6d. net.

This is the second edition of this useful little book. It has been considerably enlarged by the inclusion of a brief introduction to Psychology, which should be of great assistance to junior mental nurses preparing for their examination in this subject.

The first edition, and the booklet by the same author, "Hints to Orderlies of the Royal Army Medical Corps employed in Mental Wards," have been used for some years in addition to "The Handbook for Mental Nurses," by orderlies undergoing training as mental attendants at "D" block.

This book should find a place in the library of all medical officers who have to deal with mental patients, and who have no experience of mental hospital work, as it includes the essential practical points of nursing such

cases that cannot be learnt sufficiently in the ordinary mental diseases course which, as medical students, we all go through.

In the second part of the book on "Psychology," the author expresses himself clearly in simple words, and this should help mental nurses in what is much the most difficult subject in their course of training.

W. L. W.

HINTS ON EQUIPMENT AND HEALTH FOR INTENDING RESIDENTS IN THE TROPICS. By J. Balfour Kirk, M.B., D.P.H., D.T.M. & H. London: Baillière, Tindall and Cox, 1926. Pp. vii + 120. Price 3s. 6d.

This is a small and handy pocket-book, intended to explain the elementary principles of hygiene, so far as they relate to life in tropical and subtropical climates, for the benefit of persons going to the tropics for the first time. It is written in the form of letters to a fictitious person, Robin, who with his wife, Marjorie, and his little boy, Peter, is about to proceed to a tropical climate to take up an appointment. This device has been adopted to enable the author to indulge in a more colloquial style than would otherwise be permissible. The series of letters deals successively with the preliminary medical examination, the outfit, personal hygiene, moderation in diet, abuse of alcoholic liquors, sexual continence, rest, keeping cool, exercise and recreation, protection from malaria, mosquitoes, filth diseases, flies and other insects, disposal of excreta, the toilet, nursery hygiene, and the medicine chest. The writing is pleasant and entertaining and the advice eminently practical and sensible. The author has a wide experience of his subject as a Medical Officer of Health in Mauritius, Assistant Medical Officer in the Civil Hospital, Baghdad, and interim Civil Surgeon, Arabistan, Persia. He has also held a commission as Captain in the R.A.M.C. We know of no book which families proceeding abroad will find so handy or so easily read on the subject of preservation of health in new and unfamiliar surroundings.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

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Any demand for *reprints, additional to the above*, or for excerpts must be forwarded at the time of submission of the article for publication.

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The Committee has sanctioned the publication of correspondence on matters of interest to the Corps, and of articles of a non-scientific character under a nom-de-plume. These communications must, however, be approved by the Editor before publication.

MANAGER'S NOTICES.

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Journal
of the
Royal Army Medical Corps.

Original Communications.

PEACE TIME MILITARY SURGERY.[1]

BY COLONEL J. W. WEST, C.M.G., K.H.S.
Royal Army Medical Corps.

THE title of this address may not, at first sight, appear suitable for the War Section of this Society. While the importance of keeping alive the surgical problems and lessons of the Great War should not be forgotten, so much has been written about it that there is little I could add to your knowledge on that subject. To be a useful military surgeon in war it is essential to be a trained surgeon in peace.

The Royal Army Medical Corps exists to be prepared for war, and while the treatment of the sick in military hospitals in peace time, so as to return them quickly in a fit condition to carry out their duties, is of great importance, it is only one aspect of Corps work, which is essentially a training ground for the surgeon himself and for all the staff of assistants, anæsthetists, sisters and orderlies who make up an operating team, and for all the auxiliary branches represented by the bacteriologist, radiologist and electro-therapeutist from whom the surgeon seeks assistance in the investigation and treatment of cases. Consequently every operation carried out in peace time in a military hospital is just as essential a part of Army training as the artillery practice camp or the musketry course of the infantry man. Further, it is only by surgical experience gained in peace time, added to the knowledge derived from actual field service, that our administrative officers can decide on suitable arrangements to approximate

[1] Reprinted from the *Proceedings of the Royal Society of Medicine* (War Section).

as closely as possible the conditions which will prevail in the war area to peace time surgical conditions.

My object is to give you some idea of the peace time surgery of the Army at present and you will be able to judge of its value to the Army: (i) As a life-saving measure. (ii) Financially by rendering men fit to continue as satisfactory soldiers. (iii) By affording a satisfactory training for a surgical staff to render them fit for their duties in the field.

In order to obtain information on this subject I have selected the surgical work carried out in the Home Commands and the Colonies during 1925. The important operative work carried out in India is excluded, because the details of this work were not accessible to me.

The total figures I deal with are derived from returns sent to me every month by all surgical specialists in the Home Commands and from the annual reports of the various commands and colonies.

The detailed analysis of certain groups of cases was obtained from the case cards supplied by A.M.D.2. I specially emphasize the value and importance of these cards; if only officers realized their after-value, more care in their compilation might be exercised. Very frequently they are the important factors in deciding claims for pension by discharged soldiers, and if carelessly prepared injustice to the individual may occur, or, conversely, financial loss to the State.

I have selected two groups of surgical operation cases for analysis: one, because of the importance of the operation as a life-saving measure as well as a means of restoring men to full health; the other because it indicates how frequently operative measures are necessary in the Army, and the large number of men who are rendered efficient soldiers by means of surgery.

The extent of surgery done in the Army in peace will be indicated if I mention that, exclusive of India and of operations carried out in our Military Families' hospitals, 6,108 surgical operations were performed in one year, which is an average of 509 per month.

Of these operations 1,257 were intraperitoneal abdominal operations and from these I have selected the two groups of cases I wish to bring to your notice: (1) Gastric and duodenal ulcer; (2) appendicitis. I meant also to deal with hernia, joint operations and the operative treatment of fractures, but I soon realized that there would be no time for this.

(1) Gastric and Duodenal Ulcer.

The treatment of patients suffering from gastric and duodenal ulcer is shared by the physician and surgeon, and I do not intend to attempt to draw any conclusions from the figures I put before you as to which of these methods is the best. The numbers are certainly not sufficient to attempt this.

The prominent feature of both gastric and duodenal ulcer from the patient's point of view is some disturbance of his digestive function,

usually in the form of pain or discomfort at varying periods after the ingestion of food. Consequently, in dealing with this subject one has to consider the total number of cases in which the patients have suffered from stomach symptoms, and the actual number of these cases that have been proved to be gastric or duodenal ulcer.

During the year, for the whole Army, 1,181 admissions for inflammation of the stomach occurred and 296 in which the diagnosis was dyspepsia. It should be noted that these are admissions, and that the figures do not accurately represent the number of cases.

An analysis of the case cards for officers and men, exclusive of India, shows that forty-five cases were definitely diagnosed as gastric ulcer and fifty-nine as duodenal ulcer. Of these, twenty gastric ulcers and thirty-one duodenal ulcers were treated surgically during the year. This gives a total of fifty-one operations for these two conditions. Twenty-six of these operations were for perforation of an ulcer, and one death occurred, while twenty-five were for non-perforative lesions with two deaths. The total mortality of cases of gastric and duodenal ulcer submitted to operation was therefore 5·8 per cent.

Although the numbers are small it will be clearer if I deal with gastric and duodenal ulcers separately.

(*a*) Gastric Ulcer.

Out of forty-one cases amongst N.C.O.'s and men which were definitely diagnosed as gastric ulcer, sixteen were submitted to surgical operation, and in addition four officers were operated upon, making a total of twenty operations for this condition.

Mortality.—One death followed on these twenty operations, giving a mortality of five per cent for all operations for this condition. This one death did not actually occur until 1926, but as the patient's gastric operation took place in 1925 it must be included in the mortality figure.

The patient was an officer, and subsequently to operation he developed symptoms pointing to obstruction at the site of anastomosis. A further operation was done in 1926 when the proximal loop was found to be kinked and obstructed, and in spite of a cross anastomosis he succumbed.

After-History of Cases operated on for Gastric Ulcer.—Two cases were not restored to complete health and were invalided. In one a perforation was dealt with as an emergency in a civil hospital, but a few months later, as the patient was still suffering from gastric symptoms with hæmatemesis and only weighed eight stone two pounds, and was unlikely ever to be fit for the duties of a soldier, he was discharged. The other made a complete recovery from his gastric symptoms, but as bronchitis and a ventral hernia supervened, he also was invalided. Seventeen cases were reported as free from dyspeptic symptoms. Three of these operated upon near the end of the year still remained in hospital, but were nearly fit for duty. The remaining fourteen patients all returned to duty and none of them required re-admission during the year.

It is too early to regard all these cases as finally cured, the test of recovery in the Army is severe, necessitating the return to full military duty and a barrack room diet, which is certainly not an invalid dietary.

Perforated Gastric Ulcer.

No fewer than ten out of the twenty operations for gastric ulcer were emergency operations for perforation. As you all realize, this is a very serious condition, and according to Mr. Sherren involves a mortality of at least 95 per cent unless treated surgically.

For the fifteen years up to 1904, St. Thomas's Hospital showed a death-rate of 55 per cent for perforated gastric ulcer. At St. Bartholomew's there were sixty-nine cases from 1897 to 1905; of these 49 per cent died. At the London Hospital Mr. Sherren had sixteen cases, operated upon within twenty-four hours; all the patients recovered, but in twenty-eight cases where more than twenty-four hours had elapsed since the perforation the death-rate was 50 per cent.

The mortality for ten cases operated upon in the Army during the year was *nil*. In our cases, in addition to closure of the perforation by suture, in two cases posterior gastro-jejunostomy was carried out at the same time. In three cases the vermiform appendix was also removed, and in five drainage of the peritoneal cavity was instituted. All were operated upon within twelve hours of the perforation, which accounts for the fact that none died.

Non-perforated Gastric Ulcers.

Ten cases were operated on. In all of these the ulcer was situated at the pylorus, and the operation consisted of a simple posterior gastro-jejunostomy. One death occurred in the case of an officer already referred to. All the other patients were completely relieved of their symptoms. Eight returned to duty and one, already referred to, was invalided for bronchitis and ventral hernia.

If any conclusions can be drawn from so few cases it would appear that a simple gastro-jejunostomy is a satisfactory method of treating a pyloric gastric ulcer, and that excision of the ulcer or partial gastrectomy is hardly indicated for simple ulcers in this situation.

In two of these cases the patients had been operated upon the previous year for closure of a perforated gastric ulcer, but a recurrence of gastric symptoms in the current year necessitated the performance of a posterior gastro-jejunostomy with completely satisfactory results.

These cases suggest that a careful watch should be kept on those cases in which suture of the perforation alone was carried out this year, and that when the condition of the patient warrants it the performance of a gastro-jejunostomy at the time the perforation is closed is good practice.

One case is worthy of special mention for it illustrates the occurrence of a duodenal ulcer and, later, of a gastric ulcer in the same patient. Early in the year this patient was successfully operated upon for a perforated

duodenal ulcer which was closed by suture, but no gastro-jejunostomy was carried out. Dyspeptic symptoms recurred, and this time I had the opportunity of operating myself, and found a well-marked pyloric gastric ulcer. A gastro-jejunostomy restored him to complete health.

Previous History of Gastric Ulcer Cases.—From the history of these cases it would appear that gastric ulcer may give rise to very slight symptoms and that the process of ulceration may be rapid and lead to early perforation. Thus, in one perforated case there was no history of indigestion preceding perforation. In one case the patient admitted to slight pain only, one patient had indigestion for two months, and in one perforated case the patient gave a history of long-standing dyspepsia.

Hæmorrhage.—In only three cases is hæmorrhage shown to be the most prominent feature.

Age Incidence.—The average age of patients operated on for gastric ulcer was 30 years, ten being between 30 and 40 years.

Nine of the patients were of the rank of sergeant or above, and three were corporals. It might almost be described as a disease of non-commissioned officers.

(*b*) Duodenal Ulcer.

During the year fifty-three cases, non-commissioned officers and men were diagnosed as duodenal ulcer; of these twenty-five were treated surgically and twenty-eight medically, and in addition six officers were operated on for this condition.

Mortality.—Out of the thirty-one cases operated upon two deaths occurred, giving a percentage mortality of 6·4 per cent. In one of these death was due to hæmorrhage from the ulcer after operation, and in the other to subphrenic abscess twenty-three days after a perforated ulcer had been closed by suture. Two men died without any operation being performed. In one case a man who had never reported sick was found dead in his bed in barracks, and post-mortem examination showed that a perforated duodenal ulcer was the cause of death. In the other case the patient was admitted to hospital deeply jaundiced, delirious and critically ill. He died next day, and post-mortem examination showed a duodenal ulcer and subphrenic abscess.

Perforated Duodenal Ulcer.

Of the thirty-one cases submitted to operation for duodenal ulcer sixteen required operation on account of perforation. In fifteen of these cases the perforation was situated on the anterior surface of the first part of the duodenum and in one case on the second part.

In five of these cases, in addition to closure of the perforation by suture, a posterior gastro-jejunostomy was carried out at the original operation; in three the appendix was removed, in one of which the appendix was gangrenous.

The ages at which perforation occurred were as follows: Two at 20, eight between 20 and 30 years, and five been 30 and 40 years.

One death followed operation for a perforated duodenal ulcer. This man developed a subphrenic abscess, and a further operation to drain this was carried out twenty-three days after the primary operation, but he died from toxæmia. The mortality from perforated duodenal ulcer was therefore 6·2 per cent.

In 1899 Pagenstecher[1] reported the first series of twenty-nine cases of perforated duodenal ulcers treated by operation, and his mortality record was 86 per cent. Mayo Robson reported 155 cases with a mortality of 66 per cent. In the London Hospital from 1899 to 1908, forty-two cases occurred with a mortality of 80 per cent.

The next period from 1909 to 1919 showed a marked improvement and the mortality of 218 cases was 49 per cent. Mr. Sherren operated on forty-six cases with thirty recoveries, a mortality of 34 per cent.

The Army figure of 6·2 per cent for sixteen cases is better than any of these, as I consider it ought to be, for we are dealing with a selected young male, who, as soon as he is seized with abdominal pain, is promptly rushed into hospital. And again, all our cases are operated upon early, which is the essential factor in success. In three, the operation was carried out within three hours of the perforation. In only one case had twenty-four hours elapsed. All the others were operated upon within the twelve-hour period.

A point of interest in these statistics is the question of the subsequent history of patients who have recovered after simple suture of the perforation and for whom a gastro-jejunostomy has not also been done. When a gastro-jejunostomy has also been performed, the smooth convalescence, the earlier feeding that can be carried out, and the removal of the dread of another possible operation, are all points in favour of this procedure. It is clear that in a fair number of cases in which simple suture alone was carried out the patients were free from symptoms and returned to duty and a full diet.

On the other hand, in three cases in which a perforation had been closed by suture, one in 1921, one in 1924 and one in the present year, the patients required subsequent operation in 1925 on account of persistence or recurrence of symptoms. In two of these a posterior gastro-jejunostomy was carried out, and in the other adhesions were dealt with ; all made good recoveries.

One other case I have already referred to, in which the patient had a perforated duodenal ulcer closed by suture early in the year, and at a subsequent operation was found to have developed gastric ulcer. If the conditions favourable to ulcer formation could have been corrected by a gastro-jejunostomy at the first operation, it is unlikely that this gastric ulcer would have developed.

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[1] *Deutsche Zeitschr. f. Chir.*, 1899, lii, p. 541.

Some cases are in such a serious condition when perforation has occurred that closure of the leaking point is all that should be attempted, but cases seen early and in good surgical condition should be given the benefit of an immediate gastro-jejunostomy. This procedure only adds about ten minutes to the operation.

Final Results.—The final condition of the men who recovered after perforation must be considered as satisfactory. They all returned to duty, and, as I have pointed out in dealing with gastric ulcer, this involves a barrack room dietary.

Operations for the Cure of Duodenal Ulcer in Cases that had not Perforated on Admission to Hospital.

Fifteen cases were operated on for conditions which were diagnosed on clinical, laboratory and radiological examination as duodenal ulcer.

In one case the diagnosis was not confirmed at operation. The appendix had been removed in 1923, but pain persisted and the results of an opaque meal examination pointed strongly to duodenal ulcer. At operation a careful examination failed to reveal any ulcer and the abdomen was closed. His pain was completely relieved and he returned to duty.

There was one death amongst this group of cases. This man, who had complained of dyspepsia for three weeks, looked pale and ill, and had occult blood in his stools. At operation a duodenal ulcer was demonstrated. A gastro-jejunostomy was done, a chronic appendix removed, and a well-marked Lane's band and also adhesions between the gall-bladder and stomach divided. After operation severe hæmatemesis occurred, and in spite of blood-transfusion he never rallied. No post-mortem examination was permitted, but it is believed that the bleeding took place from the ulcer, as the suture line at the anastomosis was carefully done, and no bleeding occurred when the light clamps were released.

This case suggests that safety in this direction might be increased by cauterization and suture of the ulcer.

In two cases operation was undertaken for bleeding, one four days after admission and the other after one month of medical treatment. In both, a simple gastro-jejunostomy was done; the men made good recoveries and returned to duty.

The remaining cases operated upon presented the classical clinical and laboratory signs of duodenal ulcer, and all made straightforward recoveries with the exception of one.

In this case vomiting commenced after operation, and persisted in spite of washing out of the stomach. The abdomen was again opened and it was found that owing to a hæmatoma between the layers of the transverse mesocolon the proximal and distal loops were glued together. The stoma was patent into the distal loop but the proximal loop was blocked. A cross-anastomosis between the proximal and distal loops was carried out and the patient made a perfect recovery.

With regard to the operative technique employed :—

(*a*) It is noted that suture of the perforated ulcer succeeded in stopping the leak in all but one case. This case, referred to as a failure, terminated fatally from subphrenic abscess, but even in this case it is not certain that further leakage from the perforation occurred after suture.

(*b*) In all cases in which gastro-jejunostomy was performed the posterior no-loop method was adopted, and catgut only was used as suture material.

(*c*) The tendency has been to discard heavy and complicated types of clamps and to rely on very light clamps to avoid danger from injurious pressure, especially to the loop of jejunum.

(*d*) It is noteworthy that no case of gastro-jejunal or jejunal ulcer has been seen in military practice during the year, and this I attribute to non-removal of any mucous membrane before the anastomosis is made.

(*e*) No local treatment to the ulcer was undertaken in any of the non-perforated cases.

(*f*) The value of cauterization and suture is recognized, and the death which occurred from bleeding from the ulcer following operation might have been obviated if this procedure had been adopted.

While the general results obtained during the year by operation for these two serious conditions, gastric and duodenal ulcer, are satisfactory, it is nevertheless a little disquieting to reflect that out of fifty-one operations performed no less than twenty-six, or over half the total, had to be undertaken for the serious condition of perforation. For ulcer cases to be left until this grave catastrophe occurs suggests a lack of investigation or defective diagnostic powers, and the question arises, in how many other of the 1,487 cases diagnosed as gastritis or dyspepsia the patients are really suffering from true ulceration. Perforation may have been a blessing in disguise for some of the cases, for it led to operation, and in a large proportion to complete relief from their trouble.

(2) Appendicitis.

When I tell you that 942 admissions occurred for appendicitis during the year, with seventeen deaths, and in the Home Commands and Colonies 604 operations were found to be necessary for this condition, you will agree that the subject deserves consideration.

It would be interesting if we could glean any information as to the incidence of appendicitis among the civil population to compare with the incidence of this disease in the Army. Unfortunately there is no method of acquiring this knowledge as the returns of the Registrar-General deal only with deaths from this condition. But the records show that in 1913 the deaths amounted to sixty-nine per million, while in 1923 they had risen to seventy-four per million for the whole population.

In the Army, the year 1925 showed an increase of admissions over the previous year, 942 as against 881 for 1924.

With regard to operative mortality there are published figures with which comparison can be made, and this comparison is useful provided we make allowance for many factors which favour the Army, the most important being that all cases, with few exceptions, are sent to, and treated in, hospital from the outset, and that the great majority are operated upon in the early and favourable stage.

During the year, in the Home Commands and Colonies, 604 operations for appendicitis were performed with a mortality of six, a total percentage death-rate of 0·96 for operations at all stages of the disease. But as all the deaths followed operations for acute attacks at various stages, it gives a fairer comparison if we deal with acute attacks alone; 208 were recorded as acute; 121 are shown as chronic and 275 are not classified. If we accept all the deaths as occurring amongst the 208 recorded as acute, which is certainly over-stating the case, we get a percentage mortality of 2·8 per cent.

Mr. Adams, in a valuable paper read before the Section of Surgery of this Society last year, gave the figures for the London Hospital and St. Thomas's Hospital. These figures dealt with the mortality following operation at the various stages of the disease, and time will not permit me to go into all these, nor have I data from Army records which would usefully compare with the data from these stages.

The total mortality for all operations, including all stages of the disease, was 5·8 for the London Hospital and 8·4 for St. Thomas's Hospital. Where operation was done within twenty-four hours of the onset of the disease, the London Hospital cases show a mortality of 0·9 per cent, and those at St. Thomas's 2·3 per cent.

Mr. Sherren has drawn attention to the fact that pain in the right iliac fossa does not necessarily signify appendicitis, nor is it interpreted in this way in the Army. From personal contact with the patients I can assure you that the cases shown as operated upon for appendicitis in the Army really suffered from the disease.

Much has been written about unnecessary operations for supposed affections of the appendix, especially directed towards the removal of the appendix for the symptom of pain in the right iliac fossa, and drawing attention to the large number of cases which are not benefited by the operation; 121 cases were shown in the operation returns as chronic appendicitis, and if these had been wrongly diagnosed and the cases had been unrelieved by operation, a higher invaliding rate than eight would be expected. This figure (eight) of course refers to all cases of appendicitis acute and chronic.

The method of the approach to the appendix has varied. In a very few the old muscle-splitting operation has been employed. In a slightly larger number Battle's incision placed at the outer margin of the rectus has been employed, but by far the most common is a paramedian incision. The facilities this incision gives for a general examination of the whole abdominal

viscera has frequently been of value and other morbid conditions have been discovered.

Whilst no ill results following the other incisions have been noted in cases operated upon in the Home Commands, two cases invalided from India show the bad results of extension of an incision placed at the outer margin of the rectus, and consequent damage to the nerve supply of the muscle.

Following drainage of appendix abscesses twelve cases of ventral hernia required operation during the year, but some of these original operations had been carried out in previous years.

All the deaths from appendicitis were due to an extension of the peritoneal inflammation. In three of the fatal cases the patients underwent subsequent operations performed for obstructive symptoms. In two cases an enterostomy and an entero-anastomosis were done, and in one case a cæcostomy.

The final results of operation for appendicitis were satisfactory and the total number of cases invalided for this disease was eight.

As the total number of deaths from appendicitis is shown as 17, and as only 6 of these followed 604 operations performed outside India, it is clear that the percentage mortality following operation in India must have been higher. I have no very special reason to advance to account for this except that cases in India are liable to be complicated by intercurrent diseases such as malaria and dysentery, and the climatic conditions in the plains of India during the hot weather are less favourable to surgical operation.

I must omit reference to many types of operation, but the two groups I have so inadequately described may help in giving a general idea of the extent of military surgery in peace time and enable you to judge of its adequacy as a training ground for the surgery of war.

In considering results, and in comparing them with civilian statistics, where comparison is possible, it must be borne in mind that these operations described have been carried out by a number of young general surgeons who must be prepared to undertake any type of surgical work, and that they differ in this respect from the work of abdominal or orthopædic specialists devoting the greater part of their time to their own speciality.

Had time permitted I would have alluded to the work of many of the special departments without the aid of which good surgery would not be possible or good results obtained; of such may be mentioned the radiological, the massage, and electro-therapeutic departments.

Discussion.

Surgeon Commander H. E. R. Stephens referred to the close collaboration between the medical and surgical sections in naval hospitals during the investigation of cases of gastric and duodenal ulcers. Statistics from the Royal Naval Hospital, Haslar, corresponded closely with those given by Colonel West (p. 91).

From a Service point of view he considered that the results of gastro-duodenostomy were superior to those of gastro-jejunostomy. He did not

agree that gastro-jejunostomy should be performed as a routine measure in cases of perforation. Many perforations, he considered, were caused by acute ulceration ; many of the chronic cases were cured by simple suture ; also, in the event of symptoms recurring, there seemed no valid reason why gastro-jejunostomy should not be performed subsequently. He looked upon the operation for perforated gastric or duodenal ulcer essentially as a life-saving measure, and if gastro-jejunostomy was performed at the same time he felt that the mortality rates would increase. Unless the case was seen early and the condition of the patient exceptionally good, he did not think the increased risk to the patient's life was justifiable. The similarity of the statistics he attributed to the similar conditions under which naval and military surgeons worked. Patients were of excellent physique, and in the majority of cases they were brought under the care of the operating surgeon with the least possible delay.

	Total number	Deaths	Mortality
Gastro-enterostomy	34	2	6 per cent.
Gastro-duodenostomy	14	0	nil
Perforated gastric ulcer	28	1	4 per cent.
Perforated duodenal ulcer	10	0	nil
Appendicectomy	341	3	0·9 per cent.

Air Vice-Marshal D. Munro said that he was specially interested in the statistics of post-operative gastric and duodenal cases in which the patients were returned to full duty. Presumably these were men who were considered fit for military service at home, and in all overseas climates in peace and war. The numbers caused him surprise. He would ask one question, viz.: if any of these men relapsed whilst serving in a hot climate and eating what Colonel West had termed "barrack diet," and were afterwards invalided from the Service, what view would Colonel West take as to the part played by these factors in making the invaliding disability attributable to Service conditions? On this decision—in making which he (Air Vice-Marshal Munro) was the final authority—payment of disability pensions depended and he was thus particularly concerned.

Colonel West, in reply to Surgeon-Commander Stephens, stated that the operation of gastro-duodenostomy had not been employed in any of the cases recorded. He considered it a valuable method, but gastro-jejunostomy had proved so satisfactory in the Army that the necessity for the other method had not arisen. With regard to the peformance of a gastro-jejunostomy at the same time that a perforative lesion was dealt with, he agreed that this should only be attempted in selected cases in which the patients were seen early after the perforation and were in good surgical condition. If these conditions were fulfilled he had no hesitation in recommending that the operation should be done.

In reply to Air Vice-Marshal Munro, Colonel West said that there was no reason why patients who had been successfully operated upon for gastric or duodenal ulcer should not be passed fit for foreign service, but in the event of these men being later discharged as unfit for service such foreign service might have to be considered as aggravating their condition.

THE EU- AND PSEUDO-GLOBULINS.

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In view of recent work on the investigation of the part played in serological reactions by the various fractions into which blood-serum can be divided, the following comments on some of the published results may be of interest to readers of this Journal.

In August, 1922, it was pointed out that the euglobulin fraction of serum was mainly concerned with the Wassermann reaction, and in January, 1923, that bodies responsible for the flocculation or sigma reaction were to be found in the pseudoglobulin group proper. The suggestion was also made that such a condition of affairs might lead to an occasional discordance in the results obtained with these tests. The above papers also brought to notice that hæmolytic and agglutination substances might also be classed as pseudoglobulins.

In colloidal mastic reactions the reacting substance is again resident in the globulin fraction, and both the eu- and pseudo-globulins give irregular but often equal results. One is therefore inclined to the view that this test depends upon purely physical factors, and that the precipitation is due to the interaction of colloidal mastic and globulin.

In August, 1923, Mackie published similar results regarding the fractions of serum responsible for the Wassermann and Sachs-Georgi reactions. Recently, jointly with Ferguson Watson, he has extended his researches and has made a very valuable contribution to our knowledge of the mechanism underlying these two tests, particularly in regard to their relationship to the serum fractions of normal animals and the importance of certain antigenic factors.

It is well known that the conjoint precipitation of colloids from a solution is not indicative of identical chemical structure, and the flocculation of one may lead to the removal of both eu- and pseudo-globulin from solution. In the studies of eu- and pseudo-globulins carried out at the Venereal Clinic at St. Thomas's Hospital and at the Military Hospital, Rochester Row, quoted above, it was seen that if the usual procedure which is commonly practised in physiological chemistry is followed and a serum is diluted with nine volumes of distilled water, a faint cloud of precipitate is obtained which may be called fraction (1). After separation by centrifugalization, if CO_2 is bubbled through the water solution a fair cloud of precipitate appears and the separation of fraction (2) may be effected. The dilution of the solution with an equal volume of water and acidulation with acetic acid results in the appearance of fraction (3), and if the solution is now one-third saturated with ammonium sulphate

$(NH_4)_2SO_4$, it will be observed that the euglobulin has been removed. Half saturation with ammonium sulphate leads to the precipitation of the pseudoglobulins (4) and full saturation with the same salt to the precipitation of albumins (5).

The usual physiological belief is that the fractions (1), (2) and (3) (euglobulin) are held in solution by salts and alkalis, and that dilution alone by reducing their concentration leads to precipitation which becomes complete on neutralization of the alkali. Certain immuno-chemical authorities are of the opinion that acidulation with CO_2 splits the pseudo-globulins and a water insoluble euglobulin, a CO_2 insoluble globulin, a CO_2 soluble globulin, and albumin fractions result.

In the course of the above mentioned investigation it appeared that the most satisfactory separation was obtained by Panum's method, i.e., dilution of the serum with nineteen volumes of distilled water followed by acidulation with diluted acetic acid. By this means complete precipitation of the euglobulin group and its associated Wassermann bodies was attained, and the opacity of the diluted serum varied directly with the intensity of the Wassermann reaction and the amount of euglobulin precipitated.

When the fractional method, as above detailed, was adopted, it was found that precipitate (3) possessed unusual (strong?) deviating powers, indicating a partial separation of Wassermann substances from non-specific euglobulin. Furthermore, since some of the Wassermann bodies had been removed in fraction (2) by exposure to carbon dioxide, and as there was still evidence of their presence in the residual pseudoglobulin and albumin fractions (4 and 5) it was decided that this method of obtaining specific precipitates was extremely precarious.

The conclusions arrived at from experiments on these lines were that the Wassermann bodies were really associated with the euglobulin group as a whole, and that there was some evidence indicating that they probably possessed a greater affinity for the acid-precipitable fraction of euglobulin which approximates closely to pseudo-globulin proper.

According to Cole, the recent work of Hartley and Raistrick has demonstrated that the distribution of nitrogen as monamino acids and as bases in both eu- and pseudo-globulin fractions is practically the same, and that they differ appreciably from albumin in this respect. He also states that the separation of globulin from albumin by ammonium sulphate fractioning is very complete, and that the insolubility of euglobulin in water is probably due to associated lipoid. One might also suggest that the fraction of euglobulin which comes down readily on dilution with distilled water is characterized by a higher lipin content than the fraction which comes down on acidulation, and that the Wassermann substance only differs from the sigma body by virtue of a small lipoid attachment.

Mackie and Ferguson Watson point out that the CO_2 insoluble euglobulin from weakly reacting serum represents the whole activity of the serum, and that with strongly reacting serum the soluble pseudoglobulin and albumin

residue might also show marked activity. This was our experience with + + sera until the more effective Panum's method was adopted. In Mackie and Ferguson Watson's hands heated solutions of CO_2 insoluble fractions (euglobulin) separated from negative human and animal sera gave weak fixation reactions. In our investigations pooled negative heated sera were used with a view to eliminating fallacies, and even when the euglobulin fractions (acetic acid) were put up as a Wassermann test in a greater concentration than that obtaining in ordinary serum tests no evidence of deviation was obtained. On the other hand on several occasions the use of double strength euglobulin fractions derived from pooled negative sera of treated cases of syphilis gave rise to a weak deviation of complement. Mackie and Ferguson Watson found that the complement deviation of fractions separated from normal negative sera was not paralleled by a corresponding flocculation effect.

The abolition of the Wassermann test by alcohol injections observed by the same writers is of interest, and I have been informed by a creditable observer that a serum of a syphilitic tested before the termination of a debauch may give a negative reaction, but up to date no opportunity for proving the accuracy of this statement has occurred.

The conclusion arrived at by Mackie and Ferguson Watson regarding the nature of the Wassermann bodies is that the Wassermann syphilis reaction represents an increase of a "lipoidophile" antibody naturally present in serum in minimal amount, and in a masked state which in syphilis is non-specifically augmented in an analogous manner to the augmentation of the natural sheep hæmolysin by heterologous stimuli. Still after mentioning Taniguchi's findings the interpretation placed on their experiments with heterophile and other non-specific antigens is that "it has not been possible to augment the Wassermann substance by any of the non-specific agents we have used to a degree comparable with the marked reactions in active syphilis." One is tempted to think that the marked reactions obtaining in syphilis are to some extent an index of specific stimulation of bodies which also may be augumented but to a less degree by other processes and in the course of certain infections.

An examination of the Kjeldhal estimation quoted by us reveals that although the protein content of pooled + + and − − sera is identical; the euglobulin group in the case of + + pooled sera shows a twenty per cent increase, and in accordance with Cole's views, if the insolubility of euglobulin is due to associated lipin it would appear that in syphilis a definite increase in lipin occurs, which in conjunction with pseudoglobulin gives an apparent euglobulin increase.

It may not be considered out of place to touch on a subject which has been mentioned in previous communications, viz., the effect of malarial infections. In florid syphilis febrile manifestations may arise and the Wassermann reaction attains its maximum intensity, and these may be taken as evidence of reaction to infection. The straightforward early case

which is brought under energetic treatment gives rise to little anxiety. The danger from the point of view of parasyphilitic sequelæ lies in the chronic or inefficiently treated cases which may only give a modified Wassermann reaction. Recently attention has been focused on the treatment of these by means of malaria infections and, without venturing any opinion regarding protein stimulation and antigenic properties of non-specific agents, whether living or dead, it is interesting to note that malaria is a protozoal infection. In this disease an increase in the deviating powers of the globulin fractions also takes place and an investigation of two cases without any evidence of lues: (1) a benign tertian case and (2) a benign tertian with a dominating malignant tertian infection, yielded the following interesting results.

These sera with our usual cholesterinized antigen exhibited stronger complement deviating powers than with either malarial red cell extract or malarial spleen extract, but the addition of cholesterin to the malarial spleen extract exalted its antigenic powers both for malarial and syphilitic sera.

Further reference to these cases shows that the Wassermann reaction was much stronger and less transient in the case of the malignant tertian infection, and in the treatment of parasyphilis this may merit consideration. Malignant tertian infections have greater affinity for the cerebral and visceral capillaries, and from consideration of the foregoing, theoretically it appears that certain advantages may accrue from the employment of this species of parasite. Against this must be balanced the difficulty of controlling the infection in the early stages, its increased deadliness and the possibility that the summation of stimuli from successive benign tertian paroxysms may prove to be more beneficial than a single malignant tertian attack.

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A CRITICAL REVIEW OF THE PRESENT POSITION OF BACTERIAL AGGLUTINATION.

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The observations published in the following paper are admittedly incomplete, and the author desires it to be understood that no full bibliography is quoted, for, if this were done, the paper would extend to the dimensions of a large monograph.

The publication is prompted by the return, which has occurred recently, to the Ehrlich side-chain hypothesis as a basis for explaining the various phenomena of agglutination. Admittedly, recent workers do not specifically state that the hypothesis of Ehrlich is invoked to explain their findings, but such terms as the "antigen mosaic" [1] and the "receptor analysis method" are found scattered through the literature of the past few years, while diagrammatic representation of the same concept is to be found in many recent papers upon the subject.

This same concept is expressed, or implied, in attempts which have been made to correlate either morphological or cultural peculiarities of special strains of micro-organisms investigated, with serological characters.

Thus we now speak of "flagellar" and "somatic" agglutinin-correlation with morphological characters [2], [3]—of "granulating" and "flocculating," of "heat stable" and "heat labile" agglutinins and agglutinogens of "H" and "O" forms [4], and of "smooth" and "rough" forms [5]—correlation with cultural or other qualities.

There has been some attempt made, notably by Arkwright and by Goyle [6], to correlate heat stability and its converse with the "H" and "O" forms and the "smooth" and "rough" forms.

Further correlation has been attempted between these and the somatic and flagellar agglutinins and agglutinogens, but such correlation is by no means complete.

A third aspect of the problem is presented by the results of chemical analysis of micro-organisms and the correlation of these with serological differences.

Finally, an extremely interesting concept has been introduced by Andrewes [7] and Krumwiede [8], viz., "diphasic variation"—as it is designated by Andrewes—of bacterial species, which, according to Andrewes, bears no relation to the rough and smooth variations studied by Arkwright, by Weil and Felix, and by others.

This diphasic variation is a very fascinating subject, but it is possible that the observed facts, of which there is no question, may be so interpreted

that theories of the genetics of bacterial growth may be built upon them. If such theories be based upon incorrect interpretation, they may do much to retard the progress of bacteriology and immunology. If one could be satisfied that the facts have been correctly interpreted, they might be accepted as evidence of Mendelian genetics in the lowest forms of vegetable life, but the interpretation that diphasic variation is evidence of Mendelian genetics in bacterial reproduction is really a product of the pictorial representation of union of antigen with antibody, a method of representation which arises from the hypothesis that every reaction observed in the test-tube is referable to a separate and definite bacterial component. Such an hypothesis is not necessarily valid. The author [9] has expressed the view that "to conjure up a new antigen common to all those members of a group of organisms which happen to react with one serum, and to extend the process indefinitely, as has been done, in order to explain why sera are not strictly specific, lays the whole subject of agglutination and other serological tests under suspicion."

Attention is specially called to this, as it is the crux of the whole question of specific agglutination, for, once we accept the hypothesis that each reaction is due to a separate and distinct component or "antigen," we can explain *any* observed fact or "substantiate" *any* theory by simply adding or removing components, which "components," *it must be clearly appreciated, are hypothetical.* It is this applicability of the side-chain hypothesis to all circumstances that has led to its almost universal acceptance—an acceptance that is often unconscious—and therein lies its danger.

What real evidence have we that organisms are built up as a "mosaic of antigens?"

Before proceeding to examine the evidence available, it would be well to define the term "antigen." In the strict sense it means any substance which, when inoculated into an animal, will call forth a specific immunological response, i.e., elaboration of antibodies by the tissues of the inoculated animal. We have to demonstrate the presence of these antibodies in the serum of immune animals, and one way of doing so is by the process of agglutination, and circumstances may force us, or even habit may induce us, to carry out our test-tube reactions, including agglutination, in such fashion that we fail to demonstrate the presence of antibodies, or antigens, which, none the less, may be present in our tests. In other words, the delicacy and specificity of our test-tube experiments must be commensurate with that of the tissue response if we are to draw any conclusions concerning the relationship of one antigen to another from our *in vitro* experiments.

If *in vitro* tests be not an accurate mirror of *in vivo* reactions, we have no right to argue from the results of the former that a particular antigen is or is not present in a given suspension of micro-organisms or solution of foreign proteins.

If one unequivocal example can be given that an antigen is demon-

strable by tissue response, but is not demonstrable by experiment *in vitro*, the procedure of receptor analysis as applied to the investigations of the antigen mosaic, of rough and smooth forms, of H. and O. forms, of flagellar and somatic agglutinins, of heat stable and heat labile antigens, falls at once under suspicion. What is more important, however, is that those theories evolving from the interpretation of the results of such "receptor analysis" fall under still graver suspicion. Bearing this in mind, the evidence that organisms are built up as a pattern of antigens may be discussed.

I. Flagellar and Somatic Agglutinins.

Smith and Reagh [2], working with motile and non-motile cultures of hog-cholera bacilli, of different origins, found that the motile organism on inoculation into animals gave rise to agglutinating sera which reacted in a manner different from that produced by inoculation of the non-motile strain. The former gave large, loose clumps, while the latter gave granular agglutination.

Bayer and Reagh [10] then proceeded to study the effect of heat upon the motile organism and found that exposure to 70° C. so injured the flagella that the organism failed to agglutinate, *but such organism (heated to 70° C.) when injected into animals did produce flagellar (i.e., floccular clumping) agglutinating serum.*

Orcutt [11] followed this by a similar investigation of two variants—motile and non-motile—derived from a single strain of hog-cholera bacilli. The results obtained may be summarized as follows :—

1. The antiserum to the motile strain behaved thus :—
   (*a*) It agglutinated the motile form to a dilution of 1 in 20,480, the clumps being floccular.
   (*b*) It agglutinated the non-motile strain only to 1 in 640. The clumps being granular.
   (*c*) Absorbed by the motile strain all antibodies were removed.
   (*d*) Absorbed by the non-motile strain only antibodies—granulating—to the non-motile form were removed.
2. The antiserum to the non-motile strain behaved thus :—
   (*a*) It agglutinated the motile strain in a dilution of 1 in 1,280, the quality of the clumping being apparently intermediate between floccular and granular.
   (*b*) It agglutinated the non-motile strain to 1 in 1,280, the clumps being solely granular.
   (*c*) Absorbed by the motile strain it lost all its antibodies.
   (*d*) Absorbed by the non-motile strain it lost all its antibodies.

The results would therefore appear to be perfectly clear-cut, and the obvious interpretation is, that the motile form has two antigens—flagellar and somatic—while the non-motile strain has only the somatic antigen.

There is more than a suggestion, then, that the floccular type of clump-

ing is to be associated with the formation of a "flagellar-antiflagellar complex," and that the granular type of clumping is due to the formation of a "somatic-antisomatic complex."

In the same communication Orcutt describes experiments in which mechanically separated flagella were used for the preparation of antiserum. The serum so prepared reacted thus:—

(*a*) It agglutinated motile strains of the bacillus in a dilution of 1 in 2,560.

(*b*) It failed to agglutinate the non-motile strain even in 1 in 40.

(*c*) It agglutinated the separated flagella in a dilution of 1 in 320.

This corroborates the previous findings unequivocally and appears to *prove* that the flagellar "antigens" are distinct from the somatic "antigens."

There is, however, some doubt as to whether we can accept without question the above, which is the obvious interpretation of the findings of Smith and Reagh, of Bayer and Reagh, of Smith and Tenbroeck, of Orcutt, and of other authors. Orcutt [11] states: "Another experiment was made by absorbing (anti) flagellar serum with heated (70° C.) flagella and heated motile culture and then centrifuging and retesting with unheated flagellar suspension and motile bacilli. This experiment was performed three times, and the last time a very heavy suspension of flagella and a heavy growth of the motile bacilli (both heated) was used for the absorption. In every case the results were the same. The (flagellar) serum, after contact with the heated flagella or the heated motile culture, still gave a strong reaction when the fresh unheated culture or flagella were added. This result indicated that the disintegrated (heated) flagella not only failed to become clumped but did not even combine with the agglutinin. *However, since the heated flagellar suspension produced flagellar agglutinins in the animal, the antigenetic nature of the flagella was not destroyed by the heat, although their form, their ability to clump, and their ability to absorb agglutinins were destroyed.*"

In other words, we have here an instance in which *in vitro* experiments failed to reveal the presence of an antigen whose presence *was* revealed by the experiment *in vivo*, and therefore, unless our views of tissue reaction to the parenteral introduction of foreign protein be wrong, we must conclude that "antigens" may exist in different forms, some of which are demonstrable by, e.g., agglutination, while others are not; but these various forms may be the same immunologically. It may well be, therefore, although admittedly positive evidence of this hypothesis is so far lacking, that there is no real difference between flagellar and somatic agglutinogenic antigens but only differences in the physical state of one essential substance.

It may, of course, be argued that the experiment quoted from Orcutt's paper is artificial in that one might almost expect changes in the physical state of antigens as a result of heating and that, therefore, the argument that an "antigen" can exist in different physical states, some demonstrable

by a given method and others not, is not really acceptable. Examples, however, can be given of differences in the *in vitro* as contrasted with the *in vivo* reactions of antigens irrespective of heating. Although such examples do not indicate nor, necessarily, even suggest that a micro-organism is an inseparable unit—a single antigen—rather than a number of separable substances, none the less, they have a bearing upon the general question of the relationship between the demonstration of antigens by one method and their demonstration by another. Krumwiede *et al.* has given such an example: Two paratyphoid cultures designated "X" and "Y" had been shown to be alike. They were tested later and "X^1" was used to designate the "X" culture at the time of the later test. Absorption tests were carried out with "X^1" and "Y." The results are shown in the following figures:—

Fig. I.

"*X*" *antiserum.*	*Titre.*	
Before absorption	X^1 1/3,200	Y 12,800
Absorbed, with X^1	< 50	6,400
Absorbed, with Y	< 50	< 50

An agglutinating serum was then made by inoculating "X^1" into a rabbit and a similar test was carried out with this serum.

Fig. II.

"*X^1*" *serum*		
Before absorption	"X^1" 1/1,600	Y 1/3,200
Absorbed, with X^1	< 50	1,600
Absorbed, with Y	< 50	< 50

That is, "X^1" apparently stimulated the production of an agglutinating quality for "Y" which "X^1" itself could not remove from the serum. Krumwiede suggests that cultures exhibiting characters akin to those of "X^1" are strains undergoing "degradation."

Similar, but greater, difficulties arise when we attempt to investigate the influence of heat upon antibodies, but if, as seems proved, an antigen can exist in an undemonstrable form—undemonstrable at least by those methods ordinarily used in *in vitro* work—it seems not improbable that antibodies may exhibit kindred changes.

Orcutt [11], following the work of Smith and Reagh and of Bayer and Reagh, showed that heating immune serum to 70° C., to 75° C., rendered inert the "somatic" agglutinins without, equally at least, affecting the "flagellar" agglutinins of the serum. Her conclusion is "somatic agglutinins are destroyed to a considerable extent by heating at 70° C., and *completely* destroyed by heating at 75° C. . . . a temperature of 75° C. changes the (flagellar) agglutinins so that they react more slowly and produce a slightly lower reaction with a zone of inhibition in the stronger dilutions."

In the light of previous discussion of the effect of heat upon antigen, it seems that "completely destroyed" is too strong a term to employ, for, what is really meant is, that if you heat immune agglutinating serum to 75° C. you so alter it, that when mixed with a suspension of the organisms

used in its preparation no visible agglutination is observed That is, it is possible that, as in the case of the "flagella antigen," exposure to heat so alters the material that we fail to demonstrate the presence of the antibody although we have not necessarily destroyed it. The proof that such a change, short of destruction, may occur in antibody is difficult, if not impossible, to adduce, mainly owing to the fact that antibodies cannot be isolated, being constituents of extremely complex colloidal systems.

To sum up, therefore, it may be stated that:—

(1) The evidence for the separate existence of flagellar and somatic agglutinins and agglutinogenic antigens is that apparently separate antibodies exhibiting different degrees of thermo-stability result from the inoculation of the flagella and bodies of the same micro-organism into animals, while there is also a difference in the thermo-stability of the antigens, i.e., of the flagella and of the bodies of the micro-organisms.

(2) The evidence against unquestioning acceptance of this interpretation is that an "antigen" may be present in material without being demonstrable by the methods ordinarily employed for its demonstration *in vitro*.

II. Floccular and granular agglutination.

III. Thermo-stability and thermo-lability of antigens.

IV. Analysis of the antigenic constituents of "rough" and "smooth" strains.

These three subjects are discussed together in the following section of this communication, as they bear relationships to one another and their separate discussion is rendered difficult owing to those relationships.

II. Floccular and Granular Agglutination.

Several authors have laid stress upon the *quality* of the clumping that occurs when immune sera are brought into contact with their homologous organisms.

Under certain conditions the clumping is loose and flocculent and under other conditions it is compact and granular. An instance of this has already been quoted from Orcutt's paper [11].

In discussing the results when dealing with motile and non-motile forms of the hog-cholera bacillus, Orcutt says, "Serologically the two types differ. In an ordinary hog-cholera serum they gave the different types of clumping described for somatic and flagellar agglutination. In the production of immune serum Md. motile (the motile strain studied by this author) produced a serum which agglutinated both strains with the *expected* differences in type of clumps and titre limit," i.e., it agglutinated the motile strain, giving floccular, and the non-motile strain giving granular clumping.

Orcutt is not alone in suggesting that floccular clumping is dependent upon flagellar antibodies, and, indeed, Smith and Reagh [2] described flagellar and somatic agglutinins, while Wiel and Felix [4], Furth [16],

Breinl and Fischer [14], and Gruschka [15], all state, or at least suggest, that the floccular type of reaction is especially associated with motile organisms, and that either the flagella or something connected therewith constitutes the antigen which is concerned in the process of floccular sedimentation. In the case of non-motile organisms giving floccular clumping, the existence of something of a nature similar to the flagella of motile organisms is postulated.

The so-called "flagellar antigen" is thermo-labile, while that which is concerned in granular agglutination is thermo-stable.

This work has been interpreted thus: That flagellar and somatic agglutination could be correlated with floccular and granular clumping, and also with thermo-lability and thermo-stability of the "component antigens."

The same difficulty, therefore, arises in discussing the relationship of floccular with granular agglutination as arose in the discussion of the relationship between flagellar and somatic agglutinins, for one may again encounter the possibility that an antigen may be present in a test, but may not be demonstrable by the method employed in carrying out that test.

If we can show that a micro-organism which in the test-tube agglutinates solely in the granular manner, can, on inoculation into an animal, give rise to flocculating agglutinating serum, the correlation breaks down. If this relation breaks down one is left in doubt as to whether much stress can be laid on the quality of the clumping as evidence of the presence or absence of a given antigen.

An example may be quoted from Savage and Bruce White [16]: "Specific and non-specific emulsions of *Bacillus aertrycke* (Sweet) were prepared and boiled for one and half hours in a reflux apparatus. From these emulsions rabbit sera were prepared, very considerable doses being given. The first (intravenous) injection brought on collapse and diarrhœa within fifteen minutes. The second dose of the same size produced similar but milder symptoms. In all cases the illness was of short duration.

The sera were almost identical in titre and essential behaviour. That prepared for the non-specific strain showed considerable flocculating agglutinins, due, presumably, to insufficient boiling of the antigen, and for simplicity the case of the 'specific boiled' (i.e., prepared by inoculation of the specific strain after boiling) serum will alone be considered.

It is to be noted that the "boiled non-specific" strain exposed to ordinary non-specific homologous serum gave only granular agglutination.

There are certain points in the above quotation that call for comment, as they have an important bearing upon the subject under discussion, viz., the significance that is to be attached to the quality of the clumping and the relation thereof to flagellar and somatic agglutinins on the one hand, and to thermo-lability and thermo-stability of the antigens on the other.

(1) "The serum from the (boiled) non-specific strain showed consider-

able flocculating agglutinins." The boiled non-specific strain must therefore have contained antigen able to stimulate the production of flocculating agglutinins.

(2) "Due presumably to insufficient boiling of the antigen." Allow that the presumption is valid and the facts can only be interpreted thus: That one and a half hours' boiling was sufficient for the destruction of the flocculating agglutinogen of the specific strain, but not for that of the non-specific strain. This seems adequate as an explanation, but it is after all merely a restatement of the facts and does not help in any way to the solution of the difficulty. Indeed, these facts raise a new problem, viz.: What is the criterion of thermo-stability or thermo-lability? The point worthy of note is that the flocculating antigen present in the (boiled) non-specific strain is different from that of the (boiled) specific strain. Did it contain an antigen of a different order altogether from the corresponding antigen of the specific strain? Or is it merely a peculiar thermo-stable phase of the ordinary flocculating and therefore thermo-labile antigen? Or did one rabbit succeed in dealing with an antigen common to the two strains and elaborate therefrom the corresponding antibody, while the other rabbit did not? If the first of these questions be answered in the affirmative we should have to allow of the possibility of a whole gamut of antigens of varying degrees of thermo-stability, and each would have to be considered from two view-points.

(*a*) Stable or labile in that its presence can or cannot be demonstrated *in vitro*, and

(*b*) Stable or labile in that its presence can or cannot be demonstrated by animal inoculation.

If the second question be answered in the affirmative, then no division exists between thermo-stable and thermo-labile (*vide* next sub-section), but only varying degrees of stability, and, as we cannot completely correlate our *in vitro* with our *in vivo* experiments, conclusions based upon observation of the quality of clumping will have to be made in a spirit of extreme conservatism. If the third question be answered in the affirmative, difficulties of a like nature arise, and any interpretation of observed facts would have to undergo a very critical scrutiny indeed before acceptance as the correct interpretation.

(3) "Sera were almost identical in titre and *essential* behaviour." The fact that one of them exhibited the property of producing floccular agglutination while the other did not is therefore not essential. Surely this cannot be intended by the writer for he goes on to say: "Apparently the granulating antigens and the corresponding granulating agglutinins of the specific and non-specific phases are identical and do not follow the oscillations of the flocculating factors.

"It would, further, seem (a table is given of the experiments upon which this statement is based) that *Bacillus paratyphosus* beta and the Stanley (*suipestifer*) strains, both in the smooth and the rough condition,

are able to absorb completely, or almost completely, the granulating agglutinins from *aertrycke* sera."

This means that boiled suspensions of certain salmonella bacilli, when exposed to immune sera, clump in a granular fashion and the reaction is not specific, for boiled *paratyphoid* beta can exhaust an anti-*aertrycke* serum of its granulating agglutinins.

Furthermore, as indicated by A. M. Goyle [17], the serum of an animal immunized with boiled typhoid bacilli may agglutinate boiled Gaertner bacilli and vice versa.

It would seem, therefore, that after boiling the bacilli of the paratyphoid-enteritidis group exhibit, like rough strains of the same group, "a remarkable serological cosmopolitanism."

The facts are thus interpreted so far as the group of organisms under consideration is concerned: Agglutination in the floccular fashion is dependent upon the presence of thermo-labile antigen, that this form of agglutination is specific, and as far as the group of organisms mentioned is concerned this antigen is probably in some way related to the substance of the flagella. Agglutination of the granular type is dependent, on the other hand, upon the presence of a thermo-stable antigen. This form of agglutination may be non-specific, and appears to be related to the somatic substance of the micro-organisms.

If this interpretation be accepted we are forced to the conclusion that the heat-stable substance—apparently the bodies—of *aertrycke* bacilli and *paratyyhoid* B are the same and that a similar relationship may exist between typhoid and Gaertner bacilli. Indeed, there are indications of still wider relationships.

The acceptance, however, *assumes as proved* the following hypothesis, which may or may not be valid; that, to state the simplest case, by heating an organism consisting of two hypothetical *separate* antigens, A and B, we may *destroy* A and leave B *unaltered*. There is, however, an alternative hypothesis, which, on the information available, is quite tenable, viz., that an organism may consist of a *single* antigen, compound, if you wish, which we may call A B. This, under certain experimental conditions, may give floccular agglutination, and under other experimental conditions granular agglutination, or, indeed, no agglutination at all. (See Section I on production of flagellar agglutinins by an antigen that does not agglutinate with, nor absorb the agglutinins from, an antiflagellar serum.)

It must be admitted that absolute proof of this alternative hypothesis is lacking, but, none the less, it is not by any means fanciful, for there is abundance of evidence that the formation and quality of precipitates produced in biological tests depends upon an almost unbelievable delicacy of balance between the interacting substances. The Ramon test and all those reactions where a negative phase, or prezone phenomenon, is encountered should warn us to be careful in drawing far-reaching conclusions from test-tube experiments in which we have no method of accurately determining the precise nature of the reagents involved.

The experience with the Sigma reaction at the League of Nations Conference [18], although perhaps not germane to the point under consideration, also warns us of the extreme delicacy of reaction which may be required for the formation of precipitates.

In the case of the Sigma test, the use of a closed instead of an open water-bath, inactivation of the serum in rubber-plugged as opposed to cotton-plugged tubes, a slight variation of the temperature of inactivation, and the total as opposed to the semi-immersion of the tubes of the test during incubation, all exerted a quite unexpected influence upon the results obtained.

There is still another possibility that appears to have been lost sight of, viz., that by heating micro-organisms instead of depriving them of one of two antigens—destruction of A without alteration of B—we may well convert a single antigen, let us call it "C," into a new antigen in the immunological sense, "D." It may be argued that such a suggestion is fanciful and is not worthy of serious consideration. Animal tissues, however, seem to be able to distinguish readily between heated and unheated proteins administered parentally. Thus Besredka [19] found :—

(1) That animals anaphylactized with raw egg white were not susceptible to a subsequent "proof injection" of boiled egg white, while they were susceptible to a "proof injection" of raw egg white.

(2) The converse was equally true. Animals anaphylactized with boiled egg white were susceptible to boiled egg white, but not to raw egg white. Had (1) alone been true we could argue that heating had destroyed that portion of the antigen which was concerned in anaphylactic shock, and so consider egg white as a substance divisible into two components, thermo-stable and thermo-labile. In view, however, of (2) such an explanation will not hold good, and we are forced to the conclusion that boiling affects the antigenic qualities of the *whole* of the egg white considered as a single antigen. The subject becomes still more interesting when it is appreciated that not all anaphylactizing substances are equally susceptible to the influence of heat. Thus Besredka [20] points out that milk must be heated to 130° C. before it exhibits loss of shock-producing qualities when administered to an animal anaphylactized with *unheated* milk. It is significant that at about the temperature of 130° C. the physical qualities of heated milk begin to show definite modifications.

The contrast between egg white and milk in this connection has some bearing upon results such as those mentioned by Bruce White—unexpected thermo-stability of a so-called flocculating antigen.

There is yet another circumstance which raises doubt as to the validity of the hypothesis advanced as a result of the recent work on stability and lability of bacterial antigens. It is, that in the colon-typhoid-enteritidis group the specific antigens are those which take part in floccular agglutination—the thermo-labile antigens ; while in another group—the proteus bacilli—it appears to be granulating heat-stable antigens that are specific [4].

Although this cannot be regarded as an insuperable obstacle to the hypothesis advanced, it is, nevertheless, a finding which raises doubt as to the validity thereof. The doubt becomes accentuated when it is realized that the type of clumping of the "X" varieties of *Bacillus proteus* by typhus serum is *granular*. We have, therefore, here a peculiar state of affairs, viz., that by using the serum of animals immunized with the stable granulating antigens of the proteus bacilli we can distinguish these from one another, i.e., the stable antigen is *specific*; but it is this antigen which is susceptible to flocculation *in the granular form* by typhus serum, although there is no evidence that such serum contains true specific antibodies to proteus bacilli.

It is surprising that only the specific antigen of *Bacillus proteus* has therefore a presumably heterogenetic relationship with the blood of typhus patients, and that the type of clumping produced is the type associated with specific reaction. Although this does not invalidate the contention that the specific qualities of the proteus bacilli are resident in the so-called thermo-stable fraction, nevertheless, it warns us to exercise care in interpreting results where the quality of the clumping is to be associated with specificity or non-specificity of reaction.

This tempts the suggestion that the serological cosmopolitanism of the "stable antigen," of the colon-typhoid-enteritidis group, might be explained on the view that the relationship is heterogenetic, but in the light of Besredka and Bronfenbrenner's [19] experiments there is no need to invoke such an explanation. Furthermore (see next section), this cosmopolitanism may also be exhibited, as shown by Schutze [1] by certain degraded or rough strains of bacilli, and in this, as in certain other respects, the behaviour of these degraded forms recalls that of denaturated proteins.

We may therefore summarize the arguments thus: That although there is no question as to the facts observed concerning granular and floccular agglutination, nor is there any question as to the facts concerning the apparent existence of extreme degrees of so-called labile and stable components, yet the proof that, by observation of the two types of agglutination, we may divide up organismal protoplasm into labile and stable fractions is lacking, for there are alternative explanations of the phenomenon observed. Therefore, in the present state of our knowledge, it is not safe to correlate any quality of agglutination—floccular or granular—with a given component of a micro-organism, be that component a morphological entity such as flagella or bodies, or one made manifest only by modification of the types of reaction after exposure of the reagents to heat with a view to the destruction of one or other hypothetical component.

The fact that the degree of dispersion of a colloid has some relationship to its thermal reactions is shown by C. A. Millardo ("Il Morgagni," September 19, 1926, p. 1,185). This investigator found that an agglutinating serum for *B. coli* of titre 1 in 500, on exposure for thirty minutes to 55° C., exhibited a titre of only 1 in 400. If diluted 1 in 5 and heated for

the same time this titre was only 1 in 40. Heated for 60° C. the reduction was to 1 in 200, and diluted the reduction was to 1 in 20. When heated to 65° C., undiluted, the reduction of titre was to 1 in 100, and on heating the one-fifth dilution the reduction became 1 in 10. Heated to 70° C., undiluted, the reduction was to 1 in 50; while the diluted serum had no agglutinating power.

The following experiments which are tabulated in Tables IV to VI indicate the complexity of the process and serve to illustrate the need for caution.

Preliminary Notes on the Reagents used in conducting these Experiments.

A. *Cultures.*

(1) *Bacillus aertrycke,* designated 49 and isolated in August, 1924, from a foodstuff that was responsible for an outbreak of food-poisoning. The culture when freshly isolated gave no group reaction with para beta serum, but having been eighteen months in culture it was replated and individual colonies tested by the method advised by Andrewes [7]. Two strains were isolated from the plates. A specific colony reacting only with anti-*aertrycke* serum and a group colony reacting to about equal titre with both *aertrycke* serum and para beta serum. These have been subcultured several times, and the latter has behaved consistently while the former occasionally showed a tendency to group reaction. When this occurred the plates were discarded as advised by Andrewes. The group colony chosen was somewhat opaque and might perhaps be designated as exhibiting a degree of roughness, but was not susceptible to flocculation by salt solution alone. These two strains will hereafter be referred to as: *aertrycke* 49 specific; *aertrycke* 49 group.

(2) *Paratyphoid* beta bacillus, designated 3297, and isolated on the same day as *aertrycke* 49. It was dealt with in the same way as the *aertrycke* culture and the group strain exhibited rough characters in culture. This strain was rough, in the sense that it was flocculated by salt solution alone. These strains will be referred to hereafter as para beta 3297 specific; para beta 3297 group.

As a final check and immediately before any test was carried out the suspensions used were exposed to four different serums in a rapid "slide agglutination," the serum being used in a strength of seventy-five times its titre, as determined by agglutination for two hours at 55° C., and allowing four minutes for the reaction to take place on the slide, the slide being gently shaken. Clumping was always complete within two minutes, so that the period of four minutes appeared to be ample. The four serums used were: an anti-*aertrycke* serum which reacted specifically; an anti-*aertrycke* serum which gave marked group reactions; an anti-*paratyphoid* B serum which reacted specifically; an anti-*paratyphoid* B serum which gave marked group reactions.

If the following result graphically shown in Table I was not obtained the cultures were rejected :—

TABLE I.

	Sera			
Organism	49 Specific	49 Group	3297 Specific	3297 Group
(1) 49 Specific	++++	++++	−	−
(2) 49 Group	−+	++++	−	++++
(3) 3297 Specific	−	−	++++	++++
(4) 3297 Group	−	++++	−+	++++

It is to be noted that these serums were not prepared by absorption with the heterologous micro-organism prior to use, but were picked for the purpose in view because of past experience concerning their qualities.

Reactions of the above type have been obtained on over fifty occasions since the commencement of this investigation. They have been remarkably consistent, and sometimes the above result was obtained even when the cultures failed to pass the test advised by Andrews for the differentiation of the specific from the group phase of these micro-organisms. At first the above finding occasioned a little surprise as one might have expected the following :—

TABLE II.

	Sera			
Organism	49 Specific	49 Group	3297 Specific	3297 Group
(1) 49 Specific	++++	++++	−	−
(2) 49 Group	++++	++++	−	++++*
(3) 3297 Specific	−	−	++++	++++
(4) 3297 Group	−	++++	++++	++++*

The type of reaction marked * appears to be the exception rather than the rule with the serums employed. In order to investigate this two plates were made from the ordinary stock culture of *aertrycke* 49 and of para beta 3297, and ten colonies from each were examined by the method described. In two instances only were reactions of the type marked * obtained, while three reactions of this nature occurred out of four tests made when mixtures from five colonies taken at random from each plate were tested in the same way. It is to be noted that this was not observed, to the same extent at least, when agglutination tests in which these sera were used were performed over a range of dilutions and the tests incubated at 55° C. for two hours. It seems, therefore, not improbable that the negative results marked + in Table I were examples of a "prezone phenomenon," enhanced, perhaps, by the high concentration of the serum used and the short period of exposure.

The finding is not without interest, for if we attempt to explain it in terms of "antigen components" of the organisms investigated we meet with the following difficulty :—

Specific serum 49 appears, *under the conditions of the experiment*, to be devoid of antibodies for the group organism. This would mean that the specific organism contained no group antigen. Moreover, the group 49 organism is not agglutinated by the specific serum. There-

fore, under the same conditions, we fail to demonstrate that it contains the specific antigen, but group 49 serum, again under the same experimental conditions, is seen to contain antibodies to both the specific and group organisms, and therefore group 49 strain contains antigens for both. An apparent contradiction.

It might justifiably be argued that the method employed is unsatisfactory and that no one engaged upon a serious study of the subject would employ it, but any method of conducting such tests is, from the very nature of the reactions, bound to be arbitrary. Until then an adequate explanation of the precise chemistry, physics, or physical chemistry of the prezone phenomenon is forthcoming, we can merely record such facts as those summarized in Table I without drawing any conclusions from, or basing any hypothesis upon them.

A further examination of these suspensions was made thus: each was exposed to varying concentrations of salt and incubated at 55° C. for two hours. The following result was obtained:—

TABLE III.

	NaCl					
	M.	8/10 M.	6/10 M.	4/10 M.	2/10 M.	1/10 M.
49 Specific..	—	—	—	—	—	—
49 Group ..	—	—	—	—	—	—
3297 Specific	—	—	—	—	—	—
3297 Group	+ g.	++++ g.	++++ g.	++++ g.	+ g.	—

+ g. = clumping visible through a lens × 12 diameter and granular in character.
++++ g. = complete clumping, granular in character.

Therefore the Group 3297 was rough in the sense that it was susceptible to flocculation in a concentration of NaCl not very much in excess of that of physiological saline (2/10M. = 1·17 per cent).

The suspensions of the four organisms were then kept frozen and the following procedure carried out:—

B. Preparation of Agglutinating Serums.

A portion of (1) 49 specific, a portion of (2) 3297 specific was each divided into three parts: (1), (2) and (3):—

(1) Was formalized to two per cent and received no further treatment.

(2) Was formalized to two per cent and was left standing for four days at room temperature. It was then washed three times in distilled water and finally suspended in distilled water containing 0·1 per cent formalin.

(3) To this was added an equal bulk of saturated ammonium oxalate solution, and while in this solution of half saturated ammonium oxalate was heated to 50° C. for four hours. It was then washed three times in distilled water and was finally suspended in distilled water containing 0·1 per cent formalin.

TABLE IV.

Serum A/26 = antiserum to 49 specific formalized.

	NaCl						Na_2HPO_4					
	1/400	1/800	1/1,600	1/3,200	1/6,400	1/12,800	1/400	1/800	1/1,600	1/3,200	1/6,400	1/12,800
(1) 49 Specific—	++++ f.	++++ f.	++++ f.	++++ f.	++++ f.	++ f.	++++ f.	++++ f.	++++ f.	++++ f.	++++ f.	++ f.
(2) 49 Group—	*++++ f.	++++ f.	++++ f.	++++ f.	++++ f.	+ f.	++++ f.	++++ f.	++++ f.	++++ f.	++++ f.	+
(3) 3,297 Specific—	+ g.	+ g.	–	–	–	–	t.	? t.	–	–	–	–
(4) 3,297 Group—	++++ f.	++++ f.	++++ f.	++ f.	–	–	++++ f.	++++ f.	++++ f.	++ f.	–	–

Serum B/26 = antiserum to 49 specific formalized and washed.

	1/200	1/400	1/800	1/1,600	1/3,200	1/6400	1/200	1/400	1/800	1/1,600	1/3,200	1/6,400
(1) 49 Specific—	++++ f.	++++ f.	++++ f.	++++ f.	+	–	++++ f.	++++ f.	++++ f.	++ f.	–	–
(2) 49 Group—	++++ f.	++++ f.	++ f.	++ f.	tr.	–	++++ f.	++ f.	tr.	–	–	–
(3) 3,297 Specific—	+ g.	+ g.	+ g.	–	–	–	tr.	–	–	–	–	–
(4) 3,297 Group—	++ f.	tr.	–	–	–	–	+ gr.	–	–	–	–	–

Serum C/26 = antiserum to 49 specific oxalated, heated, and washed.

	1/200	1/400	1/800	1/1,600	1/3,200	1/6,400	1/200	1/400	1/800	1/1,600	1/3,200	1/6,400
(1) 49 Specific—	++++ f.	++++ f.	++++ f.	++++ f.	+	–	++++ f.	++++ f.	++++ f.	++++ f.	++ f.	–
(2) 49 Group—	++++ f.	++++ f.	++++ f.	++ g.	tr.	–	+++ f.	++ f.	++ f.	+	tr.	–
(3) 3,297 Specific—	++++ g.	++++ g.	++ g.	+ g.	tr.	–	++ g.	++ g.	+ g.	–	–	–
(4) 3,297 Group—	++ g.	++ g.	++ g.	+ g.	tr.	–	+ g.	tr.	–	–	–	–

TABLE IV. (A)

Serum D/26 = antiserum to 3,297 specific formalised.

	NaCl 1/400	1/800	1/1,600	1/3,200	1/6,400	1/12,800	Na_2HPO_4 1/400	1/800	1/1,600	1/3,200	1/6,400	1/12,800
(1) 49 Specific—	–	–	–	–	–	–	–	–	–	–	–	–
(2) 49 Group—	++++ f.	++++ f.	++ f.	–	–	–	+++ f.	++++ f.	+	–	–	–
(3) 3,297 Specific—	++++ f.	++++ f.	++++ f.	+	–	–	++++ f.	++++ f.	++++ f.	+	–	–
(4) 3,297 Group—	++++ f.	++++ f.	tr.	–	–	–	++++ f.	++++ f.	tr.	–	–	–

Serum E/26 = antiserum to 3,297 specific, formalized and washed.

	NaCl 1/400	1/800	1/1,600	1/3,200	1/6,400	1/12,800	Na_2HPO_4 1/400	1/800	1/1,600	1/3,200	1/6,400	1/12,800
(1) 49 Specific—	++++ g.	++++ g.	++ g.	tr.	–	–	++ g.	+ g.	+ g.	tr.	–	–
(2) 49 Group—	++ g.	++ g.	++ g.	tr.	–	–	++++ g.	+ g.	+ g.	tr.	–	–
(3) 3,297 Specific—	++++ f.	++++ f.	++++ f.	++++ f.	++ f.	–	++++ f.	++++ f.	++++ f.	++++ f.	+	–
(4) 3,297 Group—	++++ f.	++++ f.	++ f.	–	–	–	++++ f.	+	–	–	–	–

Serum F/26 = antiserum to 3,297 specific, oxalated, heated and washed.

	NaCl 1/100	1/200	1/400	1/800	1/1,600	1/3,200	Na_2HPO_4 1/100	1/200	1/400	1/800	1/1,600	1/3,200
(1) 49 Specific—	++++ g.	++++ g.	++++ g.	+ g.	–	–	++++ g.	++ g.	+ g.	–	–	–
(2) 49 Group—	++++ g.	++++ g.	++ g.	tr.	–	–	+ g.	+ g.	+ g.	–	–	–
(3) 3,297 Specific—	++++ f.	++++ f.	++++ f.	++++ f.	tr.	–	++++ f.	++++ f.	++++ f.	++++ f.	tr.	–
(4) 3,297 Group—	++++ f.	++ f.	tr.	–	–	–	+ g	–	–	–	–	–

++++ = Complete.
++ = Easily visible to the naked eye.
\+ = Visible with lens X 12.

tr. = Visible only with agglutinoscope.
f. = Flocculent.
g. = Granular.

The procedures for preparing the suspensions were chosen because of the statement of Burnet [21] that strong (two per cent) formaldehyde prevents change in suspensions of micro-organisms, which, unless so treated, are liable so to alter when washed that the type of agglutination becomes granular (R) instead of floccular (S), while exposure to half-saturated ammonium oxalate at 50° C. enhances this change. We therefore had now six suspensions :—

(*a*) 49 specific formalized to two per cent : Serum A/26.
(*b*) 49 specific formalized to two per cent and washed : Serum B/26.
(*c*) 49 specific oxalated, heated and washed : Serum C/26.
(*d*) 3297 specific as (*a*) : Serum D/26.
(*e*) 3297 specific as (*b*) : Serum E/26.
(*f*) 3297 specific as (*c*) : Serum F/26.

Rabbits were immunized against these six suspensions, the same method of inoculation with corresponding suspensions being used, and the same interval allowed for the development of antibodies in each case so that the sera might, so far as possible, be comparable.

Before beginning the immunization sample bleedings were taken and the serum tested against the six suspensions, to be assured that the animals used did not have natural antibodies to any of the suspensions employed in the investigation.

The six sera were then used for carrying out agglutinations against four suspensions—49 specific and group, and 3297 specific and group. Two suspending electrolytes were employed in the tests—NaCl and Na_2HPO_4—and these were used in a concentration equal to 1/30 M in view of the tendency shown by strain " 3297 group " to clump in presence of salt alone. The duplicate tests with Na_2HPO_4 were carried out as Shibley [22] has shown that specific agglutination may occur in presence of this salt when the electro-phoretic potential of organisms is high, i.e., to outside the zone + or − 15 millivolts. Moreover, in presence of this salt, agglutination takes place without any observable reduction of charge, although in presence of other electrolytes, immune agglutinating serum exhibits a specific charge-reducing effect which appears to be related quantitatively to the titre of the serum. Unfortunately, at the time of conducting this experiment I did not possess the apparatus necessary for determining the electro-phoretic potentials of the suspensions investigated.

C. *Experiments in which the reagents described above in A and B* (supra) *were employed.*

The results shown in Table IV and Table IVA were obtained on exposing the four suspensions to the action of six serums :—

(1) Electrolytes, 1/30 M.
(2) Volume in tubes, 1 c.c.
(3) Dilutions of serum, as shown in tables.

(4) Temperature of incubation, 55° C.

(5) Time of incubation, four hours to allow of granular agglutination being made manifest.

The following points call for comment :—

(1) It is notable that in neither instance does ordinary serum A/26 or D/26 agglutinate, unless very feebly, the specific strain of the heterologue, while three of the serums prepared from treated organisms E/26, C/26 and F/26 do so markedly and B/26 does so slightly. This is especially true of the tests carried out with NaCl as the electrolyte.

(2) The only definite floccular agglutination of the heterologue is that obtained by exposure of the heterologous group strain to the *ordinary* sera (A/26 and D/26). All other heterologous agglutinations are granular.

(3) The results obtained with Na_2HPO_4 as the electrolyte are slightly more specific than with NaCl. This is notably the case with sera prepared against "treated" organisms and is best seen in the case of serums C/26, E/26 and F/26.

(4) Attention is also called to the feeble agglutination of the group strain 3297 in presence of phosphate and along with serums E/26 and F/26. The converse in which group strain 49 is exposed to serums C/26 and D/26 does not show this so markedly, but a suggestion of the same is nevertheless seen in these tests.

An attempt to explain these findings in terms of "antigen components" presents great difficulties. Thus, while we may perhaps offer an explanation of any two contrasted series of results in terms of receptor analysis, and the explanation may appear adequate, when correlation of these two is made with a third series the explanation will not hold good, unless the hypothesis upon which such explanation is based (receptor analysis) be of such elasticity that it would serve to explain anything.

Consider, for example, the saline results with serum A—antiserum to whole formalized culture—and compare these with those of B—antiserum to formalized washed culture. The results are :—

(1) The antiserum to whole culture contains flocculating antibodies to both specific and group strains of its homologue A (1) and A (2), and also flocculating antibodies to the group heterologue A (4).

(2) Antiserum to washed whole culture contains in significant quantity only antibodies to the two homologues. It is to be noted that these antibodies are of the flocculating type.

Washing has therefore so altered the suspension used for immunization that we have succeeded in obtaining more specific results. We appear to have eliminated that component of our original culture which gives rise to an antibody reacting with the heterologous group strain to produce floccular agglutination, *but the* SPECIFIC *flocculating antigen seems to be left intact.*

Could this be shown for other micro-organisms, the explanation, viz., "that we have washed away a component," although difficult to substantiate, might still be worthy of consideration. Unfortunately, on comparing the results obtained when using serums A/26 and B/26 with those when serums D/26 and E/26 are used the hypothesis has to be modified if it is to explain the observed facts, for, although the results with D/26 are the counterpart of those with A/26, the results with E/26 are not the mirror of those obtained with B/26.

A comparison of D/26 and E/26 shows that washing has again altered the suspensions used for immunization in such fashion that the serum obtained does not give floccular agglutination with the group strain of the heterologue (E/26), but now it does give granular agglutination with the specific strain of the heterologue E (1). In the first instance discussed we only modified our immunizing suspension by deprivation, but in the second we have modified it both by deprivation and by alteration of those components which remained after deprivation.

We could plead that Culture 3297 is not Culture 49 and the two cultures may therefore behave differently when treated in the same way. Moreover, animal B is not animal E, therefore their response to similar stimuli may have been different.

There is, therefore, no positive objection to an explanation of these findings as due to alteration by deprivation of one component, except that such explanation is merely a verbal restatement of the facts observed.

Compare now the saline results A/26 with C/26, and D/26 with F/26.

A is the counterpart of D; C is that of F; and the results show in both instances that treatment with oxalate and heat so modifies the immunizing suspension that non-specific floccular agglutination is eliminated (C 4 and F 2) and non-specific *granular* agglutination introduced Cf. A (3) with C (3) and D (1) with F (1). As the same suspensions of organisms were used over all the tests there can be no question raised as to the suspension in one test being different from that in another. It is therefore solely in the immunizing suspension—assuming that the rabbits are comparable—that the change has occurred and the results in the case of E indicate that washing alone may, under certain conditions, produce this change in the antigenic quality of a micro-organism.

It seemed of interest to test out the sera A, B, C, D, E and F against the following suspensions, using 0·9 per cent NaCl as electrolyte:—

(*a*) Culture 49 ordinary stock culture known to contain both group and specific components, but in what relative proportions was not determined. A twenty-four-hour growth on agar was used and washed off in one per cent. formalin saline and used at once for the tests.

(*b*) The specific strain 49, oxalated and heated as advised by Burnet [21] in order to convert it into the R or granular agglutinating type.

(*c*) The ordinary stock culture of 3297 dealt with in the same way as Culture 49 (*a*) *supra*, the same remarks being applicable to it as to (*a*).

(*d*) Specific strain 3297, oxalated and heated.

The results obtained are shown in Tables V and V'.

TABLE V.

A/26 = *Antiserum to Specific Strain* 49 *Untreated.*

		1/400	1/800	16/00	1/3200	1/6400	1/12800
(1)	49 Ordinary ..	+++ f.	++++ f.	++++ f.	++++ f.	++ f.	+
(2)	49 Specific, oxalated and untreated	+ g.	+ g.	+ g.	+ g.	tr.	—
(3)	3297 Ordinary ..	++ f.	++ f.	+	—	—	—
(4)	3297 Specific, oxalated and heated	+ g.	tr.	tr.	—	—	—

B/26 = *Antiserum to* 49 *Specific Strain Formalized and Washed.*

		1/200	1/400	1/800	1/1600	1/3200	1/6400
(1)	49 Ordinary ..	++++ f.	++++ f.	++++ f.	++ f.	+	—
(2)	49 Specific, oxalated and heated	+ g.	+ g.	+ g.	+ g.	+ g.	—
(3)	3297 Ordinary ..	++ f.	+ g.	+ g.	—	—	—
(4)	3297 Specific, oxalated and heated	+ g.	tr.	—	—	—	—

C/26 = *Antiserum to* 49 *Specific Strain, Oxalated and Heated.*

		1/200	1/400	1/800	1/1600	1/3200	1/6400
(1)	49 Ordinary ..	++++ f.	++++ f.	++++ f.	++++ f.	+	tr.
(2)	49 Specific, oxalated and heated	+ g.	+ g.	+ g.	+ g.	tr.	—
(3)	3297 Ordinary ..	+ g.	+ g.	tr.	—	—	—
(4)	3297 Specific, oxalated and heated	+ g.	tr.	tr.	—	—	—

TABLE V'.

D/26 = *Antiserum to Specific Strain* 3297 *Untreated.*

		1/400	1/800	1/600	1/3200	1/6400	1/2800
(1	49 Ordinary ..	++++ f.	++++ f.	++++ f.	+	—	—
(2)	49 Specific, oxalated and heated	+ g.	+ g.	+ g.	tr.	—	—
(3)	3297 Ordinary ..	++++ f.	++++ f.	++++ f.	++++ f.	++ f.	—
(4)	3297 Specific, oxalated and heated	+ g.	+ g.	+ g.	+ g.	+ g.	tr.

E/26 = *Antiserum to Specific Strain* 3297, *Formalised and Washed.*

		1/200	1/400	1/800	1/1600	1/3200	1/6400
(1)	49 Ordinary ..	++ g.	+ g.	+ g.	+ g.	—	—
(2)	49 Specific, oxalated and heated	+ g.	tr.	tr.	—	—	—
(3)	3297 Ordinary ..	++++ f.	++++ f.	++++ f.	++++ f.	++++ f.	+
(4)	3297 Specific, oxalated and heated	+ g.	+ g.	+ g.	+ g.	+ g.	+g.

F/26 = *Antiserum to Specific* 3297, *Oxalated and Heated.*

		1/200	1/400	1/800	1/1600	1/3200	1/6400
(1)	49 Ordinary ..	+ g.	+ g.	+ g.	—	—	—
(2)	49 Specific, oxalated and heated	tr.	—	—	—	—	—
(3)	3297 Ordinary ..	++++ f.	++++ f.	++++ .	++ f.	tr.	—
(4)	3297 Specific, oxalated and heated	+ g.	+ g.	+ g.	+ g.	tr.	—

The following points call for comment :—

(1) The oxalated and heated organisms give only granular agglutination with the sera. Presumably, therefore, these suspensions contain only the granulating antigen. This is not so, however, for antiserum to such oxalated and heated bacilli give floccular agglutination (Table V, C (1) and Table V[1], F (3)).

(2) Neither of the ordinary cultures are devoid of flocculating antigens (Table V, A (3) and Table V[1], D (1)). Yet these cultures do not flocculate, as opposed to granulate, when exposed to serum prepared from washed, or oxalated and heated, suspensions (Table V, B (3) and C (3)). Table V[1], E (1) and F (2)). We are forced, therefore, to the conclusion, if we adhere to pictorial representation of the facts, that there are specific flocculating antigens and antibodies, and non-specific flocculating antigens and antibodies. The results of the other workers discussed in this section and the experiments quoted therefore indicate that :—

(*a*) In attempting to correlate any special quality of agglutination with specificity of reaction we must adopt an attitude of critical conservatism and accept the correlation only when it is absolutely proved.

(*b*) Very subtle changes, such as that produced by washing in distilled water, may have a profound influence upon the antigenic quality of a suspension, as determined, not by the less satisfactory *in vitro* reactions, but by actual *in vivo* experiment.

(*c*) This suggests that a purely physical explanation of agglutination, based upon a study of the precipitating and protecting qualities of colloids, may take the place of those explanations which are at present in vogue and which are based upon the assumption that every micro-organism is built up of a pattern of different "antigens," certain portions of the pattern being common to (presumably) related species.

(*To be continued.*)

RACIAL OBESITY.

By W. F. CHRISTIE, M.D.

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It has of late become the custom to attribute to defective secretion by the endocrine glands a number of physical ailments to which man is prone, and to lose sight of those personal, social and environmental factors which play a part in the moulding of the human body. The obese state has been variously ascribed to thyroid, pituitary, and ovarian dysfunction, to temperamental or individual peculiarity. While these causes may predispose to the condition, it is important to recall that fat is formed from food, and that Nature has allowed to the majority of human beings a measure of personal control over their adipose tissues. The influence of race in the production of obesity is exerted in two directions :—

(1) The transmission of national habits and customs likely to lead to corpulence.

(2) The transmission of some unknown factor, possibly endocrine, making corpulency easier to attain.

It is interesting to tabulate the evidence of the two sides in order that we may gauge their relative importance.

National Habits and Customs.

We may roughly divide the races of the world into two groups: (*a*) those with a scanty and intermittent food supply ; (*b*) those with a constant and plentiful store.

Races with a Scanty Food Supply.—The lower animal, whose sustenance depends upon the fortune of the chase, grows fat and thin by turns ; he has no larder for the safe custody of food other than his own adipose tissues ; he increases the supply of fat in his store depots when hunting times are good, and lives thereon in days of poverty. Take the cases of the seals and penguins, an excellent description of whose habits is presented in the "Voyage of the 'Scotia,'" by Three of the Staff :—

> "For the first few weeks after their arrival the penguins seem to live on their thick coats of blubber, and to abstain altogether from fishing ; this coating of blubber is very characteristic of antarctic animals, and for that matter arctic animals also. In penguins, when they return in the spring, it is fully half an inch thick, and in seals over an inch, so it will be readily intelligible how it is that even in the antarctic climate both animals can, with this reserve of food, sustain life for three or four weeks without partaking of a meal."

If we examine the life story of certain tribes of mankind, a rather similar state of affairs is found to exist. Wyeth speaks of a North American tribe thus:—

> "The Schoschonies live in an almost desert tract with but little game (buffaloes are only found in the neighbourhood of the Rocky Mountains); they grow fat at the time of the salmon fishing, but become emaciated in winter and spring."

Kellett Smith mentions another example in Central Africa:—

> "The example of certain peoples in Central Africa is interesting. They store up fat at an astonishing rate during the time of the crops and waste away to ghastly models of skeletal anatomy when the dry season supervenes. They swing regularly from one extreme to another in a manner peculiar to their own habit, and apparently without any such ill-result as would follow similar wide and frequent variations in ourselves."

Waitz says that:—

> "Lichtenstein speaks of the enormous voracity of the Bushman, and of his power of abstinence. One of them lived for a fortnight on water and salt. Like the Kaffirs they are said to grow fat again in a few days."

Such cases reveal the remarkable adaptability of the human body to meet the requirements of environment, and show how man's adipose tissues may be forced by the hard law of necessity to safeguard the future existence of the organism; through many generations down to the offspring has come the capacity for storing food to an unusual degree. To a lesser extent our own race possesses the same faculty, for I have been told of big-game hunters who feed to excess for a fortnight in the towns prior to a partial fast in the jungle.

Races with a Plentiful Food Supply.—With most civilized nations no such conditions as these prevail, and the necessity for fat storage on account of food shortage does not arise. On the other hand, social and communal interests sometimes combine to render the adipose state a highly desirable one; a superfluity of fat is regarded by some races as symbolic of beauty, by others indicative of prosperity.

While to-day we admire a slender figure, the contrary was adjudged the more beautiful a hundred years ago. There are countries even now in which the ideal type of female beauty is the fat and heavy maiden, whose shapeless limbs and sagging chins are necessary qualifications for the marriage market. Sir John Foster Fraser describes the young ladies of Tunis in the following words:—

> "A Tunisian girl is slim like other girls. As she reaches the marriageable age she takes no exercise. She gorges on kous-kous, which is farinaceous and flesh-producing. The bigger and flabbier she is, the more like a prize-fed pig she becomes,

> the more lusciously alluring is she in the eyes of Hamid. The Tunisian when he marries does not want learning. He likes nice eyes, but he must have fat."

The Kelowi of Central Africa are another tribe who love the corpulent, and it is said that "their belles must possess the weight and circumference of a young camel."

For a different purpose, the Hindoo money-lender lays on fat, for corpulence of body is their token of prosperity. By exposing his fat in public places he hopes to attract the poor and needy into the spider's web: "Such an exceedingly corpulent man must have plenty of money; would he be prepared to lend to his less fortunate brother a small proportion of his wealth?"

Apart from these cases in which social custom has laid the official stamp of approval on the obese state, there are many races who indulge their appetites to an extraordinary degree.

The Esquimaux, enjoying the present, and taking little heed of the morrow, adds considerably to his bodily bulk whenever a run of good fortune attends his fishing ventures. "Ten pounds of flesh, in addition to other food, is not unusually consumed in a day of plenty. A man will lie on his back and allow his wife to feed him with tit-bits of flesh and blubber until he is unable to move."

Mark Twain's description of the election of a "Beer King" by the students at Heidelberg University, although probably exaggerated, has enough truth in fact to be cited as an example of the voluntary powers of gluttony:—

> "The five (duelling) corps assemble at night, and at a signal they all fall to loading themselves with beer, out of pint mugs, as fast as possible, and each man keeps his own count—usually by laying aside a lucifer match for each mug he empties. The election is soon decided. When the candidate can hold no more, a count is instituted, and the one who has drunk the greatest number of pints is proclaimed King. I was told that the last Beer King elected by the corps—or by his own capabilities—emptied his mug seventy-five times. No stomach could hold all that quantity at a time, of course, but there are ways of frequently creating a vacuum, which those who have been much at sea will understand."

The modern tendency of concentrating nourishment into small bulk—white sugar, flour, tinned food, &c.—undoubtedly leads to an unwitting consumption of large quantities of fuel; for instance, the world to-day eats well over 20,000,000 tons of manufactured sugar, as opposed to a mere fraction a century ago. The United States of America are the largest eaters of sugar and candy; Uncle Sam, once symbolic of the American people, is being gradually replaced by a being of John Bull-like proportions.

Habits of lethargy are of equal importance in the production of obesity. Certain races are distinguished by their love of ease and indolence: one sees a greater number of adipose persons amongst the pleasure-loving inhabitants of the South—the Spaniard and Southern Italian, whose average of adiposity is infinitely greater than the peoples of the North. Boer vrouws, especially on farms of the veldt, are well known for their rotundity; they sit on the stoep hour after hour, eat tremendous quantities of rice, potatoes, pumpkins and "konfijts" (preserved fruits and sugar), drink cup after cup of coffee, occasionally do a little housework, or make jam. Dutch women in the country parts of South Africa become corpulent before the age of 40. The Chinaman, so long as he tills his soil, and otherwise works on the land, remains thin, but when he owns his shop and sits placidly therein, as all Chinese merchants love to do, he quickly becomes portly. The Arab, and especially the half-breed Arab, shrivelled up in the desert, becomes fat in townships.

The Endocrine Factor.

The fact that some races are of a heavier build than others—some being taller, some broader, some being thin and some fat—has been regarded as plain evidence of an endocrine peculiarity; but man inherits besides an ancestry a country to live in and a mode of existence. "The Warrori," says Burton, "are small and shrivelled black savages. Their diminutive size is doubtless the effect of scanty food continued through many generations." There is abundant corroborative evidence of the view that the smallest races of the world are those with a chronic insufficiency of food.

Can a surfeit of food "continued through many generations" predispose the offspring to an obese state? Does it do so by transmitting a depressed hormonal system? Take, for instance, the Hebrews scattered over the ends of the earth. In many ways they have assimilated the habits of the different nations amongst whom they are distributed; yet the majority of German, Levantine, Asiatic, American and English Jewesses are swathed in a common blanket of fat; probably no race in the world has so apparent a tendency to become stout after the age of puberty, or is more frequently cited as an example of racial adiposity. It is also probable that no nation is so linked in common serfdom to their racial habits and customs. Joslin says of the present generation of Jews, "overeating begins in childhood and lasts to old age." The inheritance of a depressed hormonal system may exist in them—though they show no other signs of it, and its presence has never been proved; whereas the inheritance of fat-forming habits are certain. Where an environment tending to obesity exists—as it appears to do in all plump races—it seems unfair and unnecessary to lay on their forefathers the stigma of transmitting an endocrine defect.

The occurrence of local adiposity in certain tribes is perhaps more indicative of an unknown factor which controls the deposition of fat. In

Wolof and Somali women it is especially developed in the region of the buttock; unlike the steatopygous buttocks of the Bushman tribe, fat is laid down between the fibres of the gluteal muscles, and its dependence on the food supply is proved by its disappearance during starvation. It is clear that some hereditary factor must control the deposition of fat in this peculiar area. Again, the lower the race, the more fatty does the breast become after lactation. Flower and Murrie examined a Bosjiman woman who could bring her two breasts together behind her back. FitzWilliams quotes Marco Polo as saying of the inhabitants of Zanzibar, during the reign of Edward the Third :—

> "The women . . . . are the ugliest in the world, they have great mouths, big eyes, and thick noses; their breasts are four times larger than those of any other women."

The largeness of the breast in these Bush women is the more striking because of their diminutive height; according to Armitage they average only four feet nine inches.

In contradistinction to the convincing part played in the production of obesity by errors in the national habit and custom, other evidence of a racial tendency to over-fatness—if we except the local adiposities—is far from obvious. This is only what one would expect from a consideration of familial and individual obesity—yet how often we are told that surplus fat is inherited. Corpulence is an acquired disease, and only the knowledge of how to acquire it is likely to be propagated in the family pedigree.

Editorial.

LABORATORY WORK ON MALARIA IN ENGLAND.

THE infection of general paralytics with mosquito-borne malaria has provided opportunities for studying the circumstances in which mosquitoes (*Anopheles maculipennis*) and the human host acquire infections with *Plasmodium vivax* under free and natural conditions.

The new knowledge thus accumulating has already illuminated vital problems in the natural history of malaria that have hitherto perplexed the malariologist; and a most important contribution to this knowledge is the "Report on the First Results of Laboratory Work in England," by Lieutenant-Colonel S. P. James, I.M.S. (retired), which was communicated to the Commission of the League of Nations in Paris, in March, 1926.

The work recorded in the report was carried out under the auspices of the Ministry of Health at the Horton Mental Hospital, Epsom.

In view of serious objections to the method of inducing malaria attacks by direct inoculation of blood, the arrangement officially authorized for the conveyance of malaria to cases of mental disease in English asylums is by the bites of infected mosquitoes.

The work is concerned only with adult wild-caught mosquitoes of the species *A. maculipennis*, which were collected in a country district where no malaria existed, and with two pure strains of *P. vivax*, one of which was obtained from a patient who contracted malaria in India, and the other from a case infected in Madagascar.

During twenty-four months, ending December 31, 1925, 2,630 female mosquitoes (*A. maculipennis*) were fed on patients whose blood contained *P. vivax*. The mosquitoes were fed in eighteen separate batches, comprising from 60 to 200 insects in each batch. After feeding they were kept in an incubator, in a saturated atmosphere, at a temperature of 22° F. to 24° F. to facilitate the development of the malaria parasites within the mosquito. Twelve of the eighteen batches were successfully infected, and in nine of them 100 per cent of the insects became infected with sporozoites in the salivary glands, but apparently none of the mosquitoes in six of the batches became infected.

It was found that only 530 of about 2,630 mosquitoes that were fed on malaria-infected blood subsequently became infective and were available for infecting new patients. Of these infective mosquitoes nearly all had sporozoites in their salivary glands when used for biting patients, but sporozoites were not found in the salivary glands until at least ten days after the first feed on a case of malaria.

Batches were infected in every month of the year, and included

mosquitoes that were newly hatched and some that had been hibernating in winter quarters for several months.

One hundred and forty-five patients were bitten by these mosquitoes (some on more than one occasion) for the purpose of inducing malarial 109 of the patients developed benign tertian malaria within the usual incubation period of the disease, and thirty-six did not become infected.

An important factor in relation to the successful infection of mosquitoes with *P. vivax* is that the life of the insect hosts should be prolonged for at least ten days after they had fed on infected blood, in order to allow time for the development of the sexual cycle of the parasite within them.

The author considers it probable that mosquitoes in a laboratory, where they are regularly fed and sheltered from the risks and vicissitudes of open-air life, live at least as long as they would survive in nature. Nevertheless, it was found that there was a very high rate of mortality amongst the batches of mosquitoes that were kept under the conditions necessary for the cycle of sporogony to be completed. Usually 50 per cent of the mosquitoes died during each week, and batches of 80 to 100 insects would sometimes dwindle to only 12, or even 2 or 3, by the time that the batch could be classed as infective.

It was found that the mortality was reduced, though the development of infectivity was retarded, when the insects were kept in an incubator at 22° F. The best results in infecting *A. maculipennis* with *P. vivax* were obtained at temperatures between 22° to 24° C. If, however, they were kept at a temperature of 26° F. all the insects died before the time necessary for the completion of sporogony had elapsed. Sudden changes of temperature also are inimical to the life of anopheles. A batch which has been kept at a very low temperature in the ice-chest for some days may be killed if not accustomed gradually to the required temperature in the incubator. Another cause of excessive mortality was failure of the mosquitoes to feed every day.

Observations on the rate of mortality of mosquitoes kept at different temperatures under favourable conditions in a laboratory are of interest in their application to problems of malaria epidemiology. For example, if in nature the rate of mortality of *maculipennis* is fifty per cent per week, at 24° C., and if that temperature is continuous for ten days or more in nature, then only one in every five mosquitoes which suck blood from a suitable case of malaria is likely to survive if kept continuously in that temperature until it has the opportunity to infect another person. Colonel James therefore infers that unless at least five mosquitoes bite a malaria carrier it is not likely the disease will be conveyed from him to another person.

It would appear also that the high rate of mortality of mosquitoes maintained continuously at a temperature of 26° C. and higher may be a reasonable explanation of the rarity or absence of new infections of malaria during very hot seasons.

The life of *A. maculipennis* can, however, be prolonged by keeping the insects at low temperatures, and when a batch became infective it was found expedient to transfer it to an ice-chest at a temperature of 4° to 6° C. By this means the life, and incidentally the period of infectivity of the mosquitoes, could be lengthened. It is considered that the natural conditions under which *A. maculipennis* survives the winter in cold climates are reproduced by keeping batches of infected mosquitoes in an ice-chest and, in view of the fact that wild free-living *maculipennis* are known to survive low-temperature conditions for comparatively long periods, the experiment indicates how the malaria parasite can be carried over the winter and explains the persistence of malaria infections in cool climates.

The author gives an interesting account of the life history of a batch of 300 female *maculipennis* from the time they were caught and infected with *P. vivax* in the month of August. The record proves the resistance of zygotes and sporozoites to cold and the persistence of the infecting power of sporozoites. From August 7 the mosquitoes were fed ten times on benign tertian cases of malaria. Sporozoites appeared in the mosquitoes' salivary glands on August 17, ten days after the first infective feed.

On August 22 the survivors of the batch, 150 mosquitoes, were placed in an ice-chest at 5·5° C., and after a few hours they were removed and used for infecting a patient with malaria. One hundred and twenty mosquitoes bit the patient and were then replaced in the ice-chest. On August 23, 24, and 27, the batch of mosquitoes was again temporarily removed from the ice-chest for the purpose of infecting patients, and was replaced in the ice-chest in the intervals between feeding. From August 28 to September 1 they were kept in the ice-chest at 5·5° C. On September 1 the mosquitoes were conveyed by train and cab fourteen miles for the purpose of infecting two patients. On return to the laboratory they were placed in a warm incubator at 23° C. for twenty-four hours and replaced in the ice-chest on September 2. Two of the mosquitoes were dissected on this date and the salivary glands of both of them were heavily infected with sporozoites. From September 2 to September 10 the mosquitoes were kept in the ice-chest at 5·5° C., and during this period eighteen were dissected, all of which were infected with sporozoites in the salivary glands and zygotes were found in the stomachs of eight of them. On September 10 the mosquitoes were again removed from the ice-chest, and after twelve hours in the incubator were conveyed 110 miles by train from London to Bath, where one case was infected.

From September 12 to September 18 they remained in the ice-chest; during this period nineteen insects were dissected, and all were found to have their salivary glands infected with sporozoites, and zygotes were present in the stomachs of two. From September 18 to 27 the surviving mosquitoes were kept either in the ice-chest or at room temperature during the intervals when they were not being used for infecting patients, and they remained continuously in the ice-chest, the

minimum temperature of which was 4° C. and maximum 5·5° C., from September 28 until October 14. On October 14 only six mosquitoes remained alive. They were fed upon a patient on this day and then returned to the ice-chest, the temperature of which was only 3·5° C., and remained therein until November 4. On this date only two mosquitoes remained alive. They were used to infect a patient, but only one bit, and both were returned to the ice-chest until November 9, when one of them, the insect that did not feed on November 4, was dissected. Its stomach contained sixteen zygotes, which appeared in all respects normal, and its salivary glands were heavily infected with sporozoites. The remaining mosquito, which had already bitten a patient on November 4, was kept in the ice-chest until November 16, when it was again allowed to bite the same patient, who four days later, i.e., sixteen days after the first time he was bitten, developed a typical attack of benign tertian malaria.

This record shows that one mosquito of unknown age when caught on August 5, after subsequently living about three weeks in an incubator at 23° to 24° C., and about two and a half months in a ice-chest at 4° to 6° C., and the remainder of its time in rooms, railway trains and cabs, at the ordinary air temperatures of the summer and winter, can convey malaria 102 days after its first feed on infected blood. Presumably the insect was continuously infective for ninety-two days, and it had the opportunity of injecting sporozoites into the human host on no less than forty occasions.

The author records also the life histories of three other batches of infected mosquitoes, in one of which the insects were kept for six days at a temperature of 0° to 1° C., and a further ten days at a temperature of 1° to 3° C., when the mosquitoes were taken out of the ice-chest, conveyed 180 miles in the month of December, bit three patients and successfully inoculated them with malaria. Another batch was kept continuously for three weeks at the low temperature of 4° to 5·5° C. without the mosquitoes losing their infectivity. It is, therefore, proved that the sporozoites of *P. vivax* in the glands of *A. maculipennis* are not killed when the mosquitoes live for six days in a temperature well below freezing point, or when they are kept continuously in a low temperature for three weeks. There appears to be no doubt therefore that benign tertian malaria can be carried through even a severe winter in hibernating mosquitoes.

An interesting condition which apparently has some influence on the infections of individual mosquitoes is the size of its ovaries at the time the insect sucks malaria-infected blood. In May and June, when the eggs of *maculipennis* were coming to maturity, it was found on dissecting mosquitoes whose ovaries were ripe and swollen at the time they fed on a malaria patient that, although the œsophagus was distended with blood, the enlarged ovaries had so obstructed the passage into the mid-gut that the blood could not reach the particular section of the alimentary canal in which development of the parasite could alone take place.

If the mosquito, however, becomes infected during the period it

frequents human dwellings, and subsequently the ovaries mature under the influence of approaching summer, the mosquito then leaves the house or stable and seeks a pool or marsh and, after laying its eggs, will greedily bite anyone who happens to be near the water and will inject into him the sporozoites of the malaria parasite, acquired, perhaps months before, when sheltering in human habitations.

The rôle of the marsh in certain malaria infections may be thus explained.

The report contains some interesting observations with regard to susceptibility and immunity in the human host. It is known that certain patients to whom treatment by the induction of malaria is applicable fail to develop the disease after receiving a dose of sporozoites or of malaria blood that would cause an attack in a healthy person. Failure to infect with mosquitoes may, in some cases, be due to some technical circumstance relating to the "infectibility" of certain individual mosquitoes in the batch, such as the temporary exhaustion of the supply of sporozoites in the glands of the particular mosquito that bit the patient rather than to any active immunity against malaria on the part of the patient. The author, however, does not assume that the results of attempts to induce malaria in persons suffering from general paralysis of the insane are applicable in all respects to the occurrence of the disease in normal people.

"Susceptibility," "immunity," "tolerance to the effects of the parasite invasion" and "individual resistance," are debatable subjects on which, the author states, his observations have not yet thrown much light, but it is considered justifiable to say that technical reasons for failure of inoculation or reinoculation have not yet been sufficiently examined. The author quotes some results of the infection of patients who were reported to be immune after one or more attacks of malaria had been induced by the direct blood method.

Seven patients who had been successfully infected and reinfected several times by injection of malaria blood, at last apparently became immune to further inoculations, but on subjecting them to the bites of infective mosquitoes all again developed malaria attacks between twelve and twenty-three days after they were bitten.

The strain of *P. vivax* with which the patients were successfully infected as the result of mosquito bites was, however, a different strain from that with which the patients had previously been inoculated and reinoculated by the direct blood method, and the inference drawn from these experiments is that several infections with one strain of *P. vivax* induced by the direct blood method do not give rise to immunity against infection with another *vivax* strain conveyed by the bites of mosquitoes. Moreover, it was found that one attack of malaria induced through the agency of mosquitoes conferred no immunity to a second attack of benign tertian fever induced by mosquitoes infected with the same strain of *P. vivax*. The character of a second infection is quite different from that

of a primary infection. The temperature charts show that a striking change in the patient's reaction to malarial infection has occurred; his blood or tissues have acquired some quality which previously they did not possess. But we are not justified in assuming that the new quality indicates the presence of "immune bodies." It may be that a simpler process is at work. With regard to the fact that some individuals are refractory to the parasite of malaria while others are so susceptible that the parasite multiplies in their blood inordinately and infects a very large proportion of the red blood-cells, the author expresses the opinion that this difference between susceptible and resistant individuals is due to some relatively simple cause, such as a slight modification of the normal alkalinity of the blood, or to some change in its content of lecithin or other protein, rather than to the presence of immune bodies—a problem, however, that the biochemist may possibly solve.

A most interesting and important chapter in this fascinating report is that in which the author records his clinical observations on induced malaria. They may be summarized as follows :—

(1) In a primary attack of untreated benign tertian infection three stages may be recognized: (*a*) an initial stage beginning as a gradually increasing irregular fever lasting two to five days, which towards the end of this period becomes intermittent and is sometimes followed by an intermission lasting twenty-four to forty-eight hours; there are no rigors in the initial stage; (*b*) a second or fully-developed stage in which the periodicity is not tertian but quotidian; this stage may last ten days or more and there is a rigor every day; (*c*) a final stage in which the fever changes from the quotidian to the tertian type, and may gradually become less severe until after some days the attacks may cease to occur—so-called spontaneous recovery.

(2) Ten per cent. of cases of primary benign tertian malaria run a tertian fever throughout, but in these cases inquiry should be made as to whether the patient has previously suffered from malaria.

(3) In primary attacks it is seldom possible to correlate the course of the fever with the stages of growth of the malaria parasite.

In cases that were infected by only one bite of one mosquito the temperature chart in the primary stage shows a sharp febrile attack recurring regularly every day, and the first few parasites that can be detected in the blood are all of the same stage of growth; two or three days later, however, parasites in several stages of growth are found, and this condition persists into the second stage of the fever.

It is a curious fact that a patient who has been infected with a pure strain of *P. vivax* by only one mosquito bite on one occasion, nearly always shows a quotidian type of fever in the second or fully-developed stage of the attack, during which groups of parasites in all stages of growth are always found.

There is, however, no reason to assume that the fundamental forty-

eight-hour cycle of the benign tertian parasite does not hold good, and the author believes that he has been able to demonstrate the forty-eight hour cycle of the parasite from the earliest date of a positive blood examination; but the parasites do not all grow at the same rate, nor do they all sporulate at the same time, consequently, after one or two febrile paroxysms, the blood-picture, which at the first positive examination showed parasites in only one stage of growth, may now show parasites in two, or even three, phases of schizogony. The irregular remittent temperature which is characteristic of the initial stage of a primary attack is said to be probably the clinical expression of the different groups of parasites sporulating at different times. Later the quotidian character of the fever is determined by two groups of parasites, viz., very young rings and fully-grown schizonts becoming dominant, in which case the temperature chart of a primary attack shows the height of the fever to be nearly equal on alternate days, and the fever always higher on the first and third day than it is on the second and fourth.

Finally, since the trend of benign tertian malaria is towards recovery and the disappearance of the parasites from the peripheral blood, the groups of parasites which are least numerous naturally disappear first, with the result that towards the end of the second, or developed, stage of the malaria attack only one group of parasites remains, and the temperature chart then shows true tertian periodicity.

(4) A second attack of malaria resulting from a second infection by mosquito bites presents a clinical picture very different from that seen in a primary attack, even when an interval of several months intervenes between the first and second infection. The second induced attack begins with a true tertian fever, there is little or no initial stage, and no quotidian fever precedes the onset of the tertian stage, but the parasite findings resemble those of a primary attack.

After four or five tertian paroxysms the type of temperature may change from tertian to quotidian, indicating the predominance of two broods of parasites in the blood of the patient.

(5) The clinical features of a relapse resemble those seen in a second attack, but the blood-picture shows the presence of gametocytes much earlier than in a fresh infection.

(6) The author has so far been unable, because of the variations in the degree to which the human host reacts to malaria infection, to determine whether the duration of the incubation period or the severity of the attack is influenced by the amount of the infective dose, i.e., by the quantity of the sporozoites injected by the mosquito. Neither has he observed that relapses are more frequent among patients infected by a large dose, or on several occasions, than among those who were infected by fewer bites or on one occasion only.

Examples are quoted in which the duration of the incubation period was as short as 7 and 8 days in patients bitten by 3 and 10 mosquitoes

respectively, and as long as 18 days and 17 days in patients bitten by 60 and 120 mosquitoes respectively. The longest incubation period recorded is 23 days, but the incubation is usually from 10 to 12 days. Parasites are not often found in the blood until the second or third day after the first rise of temperature.

In a concluding summary the author discusses the application of his experimental work to the solution of important problems in the occurrence of endemic and epidemic malaria in nature.

His experiments show how difficult it is, even under circumstances that are considered to be more favourable than those usually found in nature, to ensure that a few mosquitoes in a large batch shall be sustained under the required conditions and for the period necessary for them to become successful transmitters of malaria. He considers it probable that not more than five per cent of the potential malaria-carrying mosquitoes which emerge from the larval stage in nature will ever have the opportunities that are required, or enjoy the conditions that are necessary, for them to play the rôle of vectors of malaria.

If this conclusion is valid, it will be realized that measures directed against the breeding-places of mosquitoes as a whole have been to a great extent wasted, and that such measures must now be reconsidered in the light of new knowledge which undoubtedly indicates that the successful control of malaria depends more on the exact knowledge of the life history of a few individual mosquitoes that succeed in becoming transmitters of malaria than on the general knowledge that the disease is spread by mosquitoes of a particular kind.

The main factors in limiting the proportion of mosquitoes that can acquire infectivity are summarized as follows :—

(1) The rarity of patients who are good infecters of anopheles.

(2) The fact that a patient in a primary attack is not infectious to mosquitoes until ten days have elapsed from the beginning of his illness (by which time he should have been treated with quinine).

(3) That a mosquito must feed several times on a patient in order to become infective unless it happens to bite an exceptionally good "infecter."

(4) That when the temperature is sufficiently high for the development of the parasites, the mosquitoes which harbour them must have an opportunity of feeding every day.

(5) That when the insects feed on certain vegetable food, glucose, dates, raisins, bananas, as well as on blood, they are liable to become infected with moulds, and the probability that they will become transmitters of malaria is thereby much reduced.

(6) That there are certain physiological factors and chance factors which interfere with infection, such as the growth of the ovaries preventing the infectious meal of blood from entering the mid-gut of the mosquito, the loss of gametes by quick evacuation of the blood-meal and the situation of

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the fertilized oökinetes in the mass of undigested blood in the mosquito's stomach; also factors of temperature and humidity, as already detailed.

Malaria must therefore be regarded as a disease which does not spread unless a large number of special conditions are fulfilled. The study of these conditions helps to explain why it is usual to find only a low percentage of infected mosquitoes in nature, also that malaria in nature is seldom or never contracted except in certain houses or shelters where these conditions obtain. Colonel James's experiments strengthen the opinion that malaria is essentially a household disease, and the inference is that malaria should be dealt with in the houses of the people rather than in the environment.

The fact that in many places all the inhabitants may be infected with malaria is explained by the fact that a mosquito having once become infective may retain its infectivity for as long as three months, because the glands are replenished from time to time with sporozoites from oöcysts which ripen and rupture at different times. It is obvious that a mosquito in this condition may readily infect all the inhabitants and many of the visitors to the house in which it shelters. Colonel James's experiments having been carried out in England with *A. maculipennis* do not warrant the assumption that other species of anopheles under tropical conditions will necessarily behave in a similar manner.

Since the oöcysts and sporozoites are unaffected by cold, the persistence of the mosquito's infectivity through the winter accounts for the occurrence of primary attacks of benign tertian malaria in Northern Europe during winter and early spring.

Our review of this invaluable report is necessarily somewhat sketchy, but our object is to bring it to the notice of our readers in out-of-the-way places, and to arouse their interest and curiosity so that they will consult the original and follow further developments in this entrancing research.

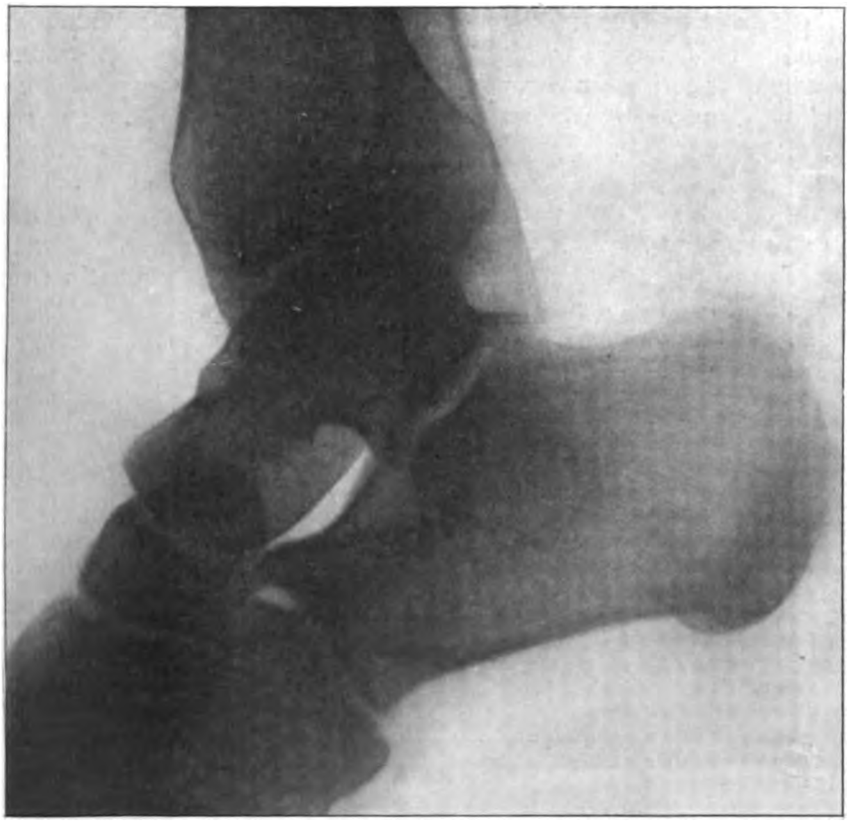
The original report can be obtained from Messrs. Constable and Co., Ltd., 10 and 12, Orange Street, London, W.C. 2.

Clinical and other Notes.

A NOTE ON THE OS TRIGONUM.[1]

By Major BROOKE CHURCHILL.
Royal Army Medical Corps.

A few cases have come to notice lately of an injury to the foot which is not uncommon or particularly obscure, but at the same time gives scope for considerable differences of opinion. This is the separation of a tubercle from the posterior part of the astragalus.



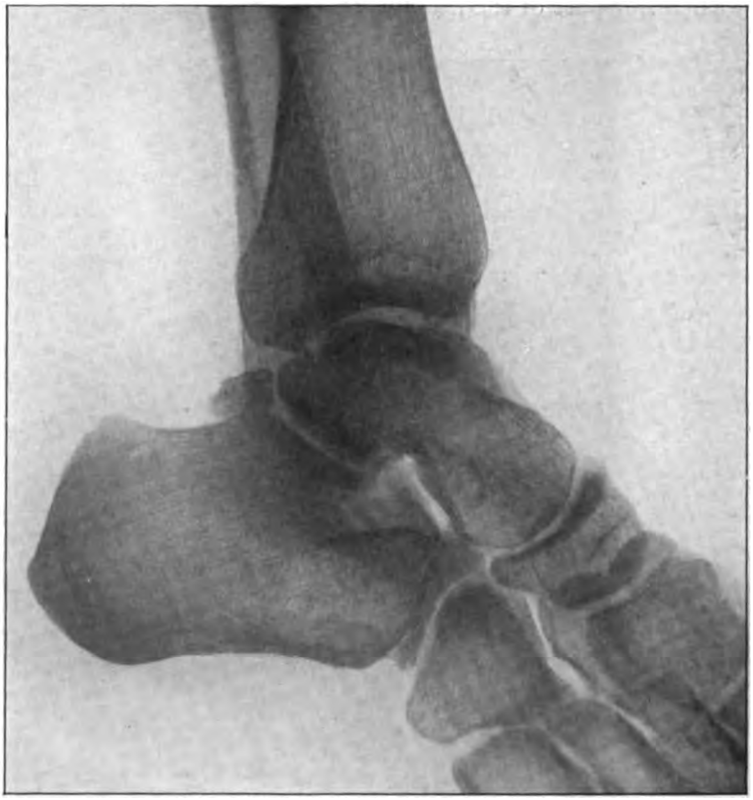
No. 1.

This injury is frequently a snare to those who have not had experience of it, and a note on some illustrative cases may prove useful.

Anatomically there are two tubercles at the posterior surface of the astragalus, separated by a groove running downwards and medialwards, for the tendon of the flexor longus hallucis.

[1] From a paper read before the Malayan Branch of the British Medical Association.

The external tubercle is the larger, and serves for the attachment of the posterior talofibular ligament, formerly described as the posterior fasciculus of the external lateral ligament of the ankle-joint. This tubercle may have an ossific centre separate from that of the body of the bone, and may remain during life ununited; in this condition it is known as the os trigonum, and appears in radiograms as a separate shadow. Usually it is developed from the main ossific centre of the astragalus, and even when it has a centre of its own it generally unites with the body of the bone.



No. 2.

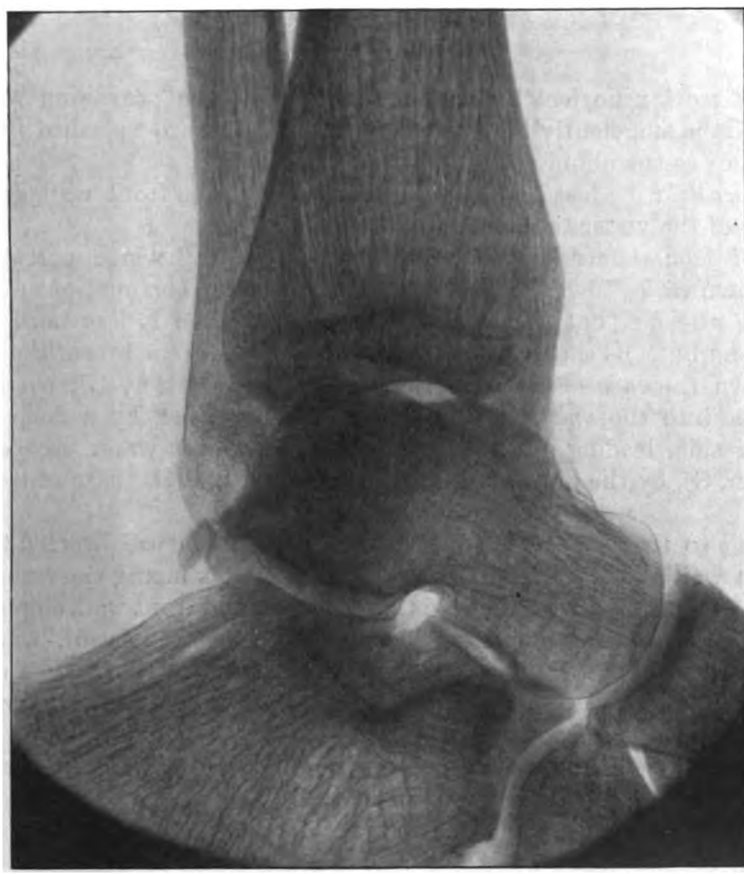
Quain states that the os trigonum exists as a separate bone in 7 to 8 per cent of all cases. Developmentally it arises from the non-fusion of the two primitive tarsal bones, the tibiale and the intermedium, which, in man, join to form the astragalus, but exist as separate bones in turtles and some other reptiles.

Whether developed from a separate centre or not the tubercle varies considerably in size, and when it forms part of the main bone is subject to fracture like any other bone; in its case probably from the drag of the posterior talofibular ligament.

There are three possibilities, the non-recognition of which has led to confusion in the past.

Radiogram No. 1 illustrates one possibility, namely an exceptionally long process which is unquestionably part of the main bone; this is a condition which might very well precede a genuine fracture.

Radiogram No. 2 illustrates a second possibility and is a genuine case of os trigonum, i.e., the process has not only been developed by a centre



No. 3.

separate from the main bone but has remained separate throughout life. When such a case is observed fluoroscopically and the foot is inverted the os trigonum can be seen to separate itself from the astragalus, following the movements of the fibula, showing that the os trigonum is bound to the latter bone by the posterior talofibular ligament.

Radiogram No. 3 illustrates a case of a small piece of bone detached from the upper and posterior part of astragalus. The symptoms were fairly severe and the patient remained a month in hospital. I think this is

a genuine fracture; the jagged edges of the fragment bear this out. Whether the process was developed from a separate centre or not is uncertain, but probably it was part of the main bone from which it was broken off.

PLAN OF SANITARY DHOBI GHAT.

By Lieutenant-Colonel L. REYNOLDS.
Indian Medical Service.

Front wall, nine feet high. Erected against the prevailing wind for choice. It is sufficiently high to catch all the forward splashes from the wet clothes as the dhobi swings them over his head.

Side walls, nine feet high, run backwards from the front wall, as far as the back of the water tanks.

Dhobi stones faced with teak wood, with transverse corrugations, slope downwards towards the front wall. The corrugations help in kneading the dirt out of the clothes, the wood face is less hard on the clothes and buttons than stone. The dirty water squeezed from the clothes runs down the face of the dhobi stone into the gutter, G^2, overflow at the sides into the water tank being guarded against by a deep groove on either side, leading into the gutter, G^2. This dirty water escapes from the gutter, G^2, by the drain, D^2, into the gutter, G^3, at the base of the dhobi stone.

Owing to the slope splashes from the dhobi stone are directed towards the front wall and away from the dhobi, who stands facing the front wall.

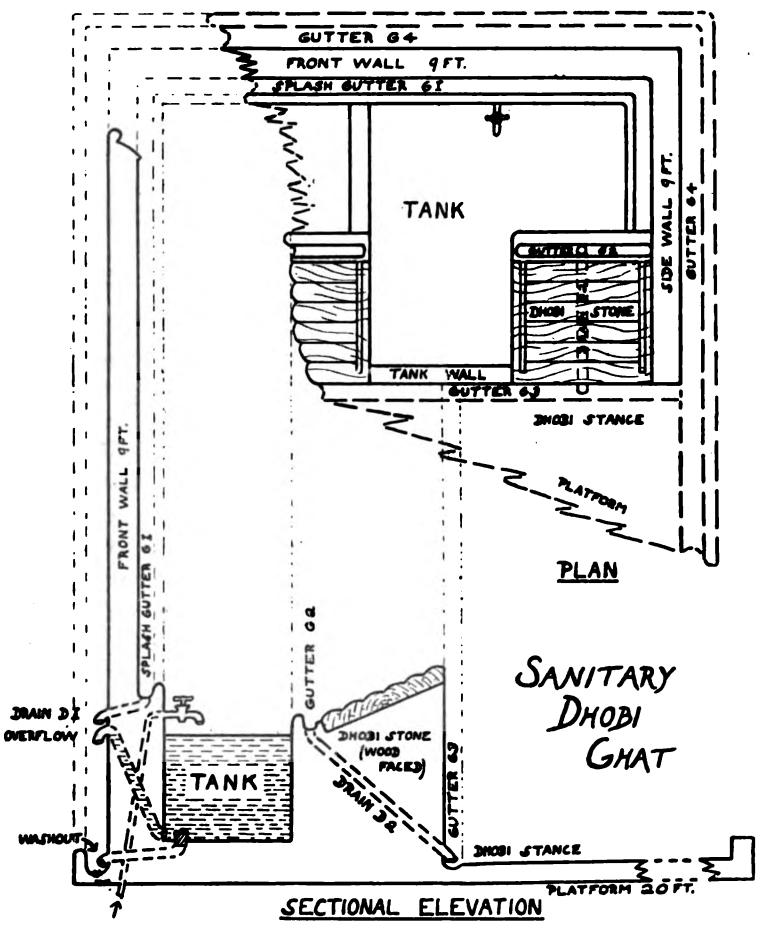
A splash gutter, G^1, runs round the side walls and front wall, sloping from the side walls on either side to the centre of the front wall, where the water passes by the drain, D^1. This gutter collects all splashes of dirty water from the walls and prevents them from fouling the water in the tank.

The tank contains the water for washing the clothes. At the bottom of the tank is a washout escape which is closed with a removable plug of wood. There is also an overflow pipe from the bottom of the tank, opening above at the front of the front wall, just below the level of the top of the tank. Thus when the tank is overfull of water the overflow is from the bottom of the tank where the water is dirtiest. This overflow does not foul the platform.

The platform extends backwards twenty feet from the tank and is sufficient to catch all backward splashes from the clothes when swung by the dhobi. It is suitably sloped, so that all dirty water runs into the gutter, G^4, on the right-hand side. This gutter is continued round to the front of the ghat, where the water is disposed of by a soak-pit or irrigation area, according to the nature of the soil and rainfall.

This dhobi ghat was erected by me at the Indian Station Hospital,

Maymyo, Burma, and worked very satisfactorily. The front and side walls give good shelter to the dhobis from wind and rain. The dhobis do not stand in the tanks and keep surprisingly dry, but at times get wet, and wind playing on their wet clothes is very likely to cause a chill. Before building this ghat the dhobis, four of them, were frequently going sick. After the ghat was in use, the only casualty in eighteen months was due to syphilis, contracted in the usual way. The ground around the



ghat never became fouled, even in the rainy season. The dhobis were obviously pleased with the ghat, and worked willingly and well. The plan has been deposited with the garrison engineer, Maymyo. These diagrams, kindly drawn by Capt. H. Williamson, I.M.S., are from memory, so the height of the walls and size of the platform should be verified before building. This can easily be done, as I did originally, by stretching a bed sheet between two upright standards and marking on the ground where

the dhobi should stand. The dhobi then swings wet clothes, and the extent of the splashes is noted on the sheet in front and on the ground behind the dhobi. Splashes from the dhobi stone may be ignored, as they will reach scarcely halfway up the front wall. The height of the dhobi stone should also be checked; on this point I consulted the head dhobi.

The ghat cost Rs. 800 to build in Maymyo, where the cost of materials and labour is much higher than in India. Walls are of brick, dhobi stones of brick and cement, with teak-wood face bolted on, the bolt heads sunk and covered with wood caps level with the surface. These stones must be stoutly built, otherwise the beat of the clothes will jump the wood face. Platform is made of concrete slabs.

METHOD OF STERILIZING SMALL QUANTITIES OF WATER.

By Major S. M. HATTERSLEY, M.C.

Royal Army Medical Corps.

The following method can be used for sterilizing water by means of water-sterilizing powder in small receptacles such as petrol tins, camel tanks, water bags, water casks, etc.

Carry out Horrocks' test on the water and determine how many measures of water-sterilizing powder are required for 110 gallons. Multiply the number of measures required by the number of gallons the receptacle holds. The figure so obtained will be the number of measures of the black-cup solution it is necessary to add to the water in the receptacle.

Example.—It was required to sterilize the water in a five-gallon tank. A Horrocks test was carried out and it was found that the water required two measures of sterilizing powder to 110 gallons. Multiply two by five, equals ten. Ten measures of the solution in the black-cup of the Horrocks test were added to the water in the tank.

The measure referred to is found in each four-ounce and thirty-pound tin of water-sterilizing powder. There are also two of these measures in a water-testing sterilization case.

Travel.

GIBRALTAR.

By Brevet Colonel W. R. P. GOODWIN, D.S.O.
Royal Army Medical Corps.

Gibraltar, that formidable rocky sentinel at the entrance to the Mediterranean, which so many of us see from the decks of passing ships, and where not a few of us spend a foreign tour, has features so peculiarly its own and a history of such interest, that perhaps a short note on the station may be of some use to those who may find it their destination.

The history of Gibraltar is of extraordinary interest. The fame of "The Rock" dates back to very early days, and we find both Greek and Roman historians writing of it.

Until early in the eighth century it was known by the name of "Mons Calpe." In 711 a Moorish chief, Tarik-Ibu-Zeyad, conducted an expedition from Ceuta on the southern shore of the Straits, and landed on Mons Calpe, which he re-named "Gibel Tarik" (Mountain of Tarik); hence came the present name.

This Moorish leader, Tarik, having taken possession of the Rock, pushed northward into the mainland, and after considerable fighting took Toledo, and established the Moorish dynasty which was destined to hold sway for 800 years.

From this time for close upon 1,000 years Gibraltar had the unenviable distinction of being the principal bone of contention in Southern Europe, being ever eyed with jealousy by Christians and Mohammedans. The place passed through no less than fourteen sieges and changed hands nine times.

Gibraltar became a British possession in 1704, during the war of the Spanish Succession, when Admiral Sir George Rooke invested and took it after a siege lasting only three days. This was the eleventh siege. The twelfth siege was a joint attempt by France and Spain to take the Rock, and failed. The thirteenth and fourteenth sieges were undertaken by Spain alone, and also ended in failure. The fourteenth siege, known as "The Great Siege," commenced in 1779 and lasted until 1783. During this siege the British garrison lost 333 men from wounds and 536 from sickness. The Spanish losses amounted to 6,000 men. The commander of the fortress during this historic siege was General Sir George Eliot, who was afterwards raised to the peerage as Baron Heathfield of Gibraltar. A statue to this gallant soldier now stands at the edge of the Alameda Gardens in Gibraltar.

The period following the conclusion of the great siege, like many other post-war periods, appears to have been troubled with internal unrest. The historian relates how a system had come into vogue whereby the salary of the Governor was principally defrayed by the income derived from wine-house licences. One Governor, it is said, derived £7,000 a year from this source alone. The result was such as might be expected, " the troops were disorganized with shameless intoxication, and discipline was almost at an end." In 1802 a Royal Governor was appointed who set himself to put an end to the lamentable state of affairs. He received, however, little support, either from the Government at home or even from his own staff; his efforts in consequence failed to achieve their object, and he was recalled within a year.

In 1804 Gibraltar was visited by the first of a series of terrible epidemics of yellow fever; 5,733 persons out of a population of 15,000 died in a few weeks. Three subsequent epidemics occurred, and finally a commission was appointed to inquire into the matter.

After the Battle of Trafalgar, in 1805, the damaged ships of the British Fleet put into Gibraltar to refit. On October 28 the "Victory" entered the Bay, bearing Nelson's body on board. The body was enclosed in a cask filled with brandy to preserve it.

The Trafalgar Cemetery, at the southern edge of the town, remains as a standing memorial to the heroes of that day.

The Rock of Gibraltar is a bold and impressive promontory running out into the sea at the entrance to the Mediterranean. Approaching it from the west one cannot but be struck by its vastness and grandeur. It runs nearly due north and south, being 2½ miles long and three quarters of a mile wide at its widest part. The western slopes are well covered with vegetation and present a restful green aspect throughout the year; at their foot lie the town and Admiralty Dockyard. The eastern side of the Rock is for the most part precipitous cliff, devoid of vegetation. At its northern aspect the Rock ends in a towering unbroken cliff 1,400 feet high, and through this cliff-face run the famous galleries. Running north from the foot of this cliff is the North Front, a stretch of flat ground where we find rifle-ranges, cricket and football grounds, the race course, and the kennels of the Royal Calpe Hunt, with, on the west side, the North Front Hutments, accommodating two companies of infantry. Further north is the Neutral Ground, a dry sandy belt about 1,000 yards in width, traversed by one road which leads to the entrance into Spain and the scattered town of La Linea. At the southern end the Rock shelves steeply down to Europa Point, with its lighthouse and Artillery Barracks.

On the western slopes of the Rock are two groups of Infantry Barracks (South Barracks and Buena Vista Barracks), and above the latter the Military Hospital.

The Rock is composed of compact limestone or grey dense marble.

Animals are few. Rabbits are fairly numerous and there are a few

foxes. The Rock Apes, a species of Barbary ape, at one time numerous, have of late years dwindled, and there now remain only a few. They are carefully guarded, and one of the local garrison appointments is "Officer in Charge of Rock Apes." The apes are not very often seen nowadays; they pay occasional visits to houses on the edge of the town, snatch up anything that particularly takes their fancy, and retire to their rock fastnesses. A story is told of a certain lady coming downstairs to breakfast and finding an ape seated in her husband's chair.

The climate of Gibraltar is on the whole pleasant and healthy, though sometimes oppressive in the summer. Neither heat nor cold are ever excessive, the maximum shade temperature being 95° F. Frost is very rare. The average annual rainfall is thirty-seven inches. This rainfall is spread over the months November to April. Occasional deluges occur, and 9·13 inches in twenty-four hours has been recorded.

The most unpleasant climatic feature is the "Levanter," the wind blowing from the east and a cloud of condensed moisture lying like a blanket on the Rock. It is certainly unpleasant, but not quite so bad as the historian would lead one to suppose when he describes it as follows: "Dull aching pains creep through the bones, the tongue is parched and dry, while the atmosphere is saturated with a sticky dampness; appetite vanishes, energy leaves you, and an oppressive languor paralyses both mind and body. And it is not man alone who suffers; animals move about uneasily, beasts of burden weary under their loads, dogs hide themselves, birds cease their song, even the plants and flowers wither under the influence of the distressing 'Levanter.'

During the summer months sandflies and mosquitoes, *Culex* and *Stegomyia*, are apt to be troublesome.

The fresh water supply is derived from rain collected from roofs and catchment areas, and stored. The catchment areas are of considerable extent and yield an average of 600,000 gallons of water per inch of rainfall.

Water is also obtained from certain wells, sunk at the north front in 1868. This water is slightly brackish, is known locally as "sanitary water," and is used for washing, house sanitation, and road watering.

The civil population of Gibraltar is about 17,000. British population 16,000. The garrison consists of five Batteries of Artillery, three heavy and two medium, one Company of Royal Engineers, two Battalions of Infantry, one Company R.A.S.C., one Company R.A.M.C., and detachments of R.A.O.C. and R.A.P.C.

The Military Hospital, built in 1904, is situated on the Europa Road, overlooking the Infantry Barracks at Buena Vista. It consists of three main blocks and an officers' block, and is equipped normally for 152 beds, expandable to 252. The Naval Hospital was closed some years ago and naval patients are now received in the Military Hospital. Part of the Naval Hospital is still retained for medical purposes and is used as an isolation

hospital. The annual visit of the Atlantic Fleet in the early part of the year adds a good deal of work and interest to the Military Hospital staff.

The Army medical establishment consists of a Deputy Director of Medical Services, a Deputy Assistant Director of Hygiene, and No. 28 Company, R.A.M.C., consisting of eight executive officers, a quartermaster, and eighty-one other ranks.

The Colonial Hospital, situated in the upper part of the town, cares for the civil community, and also receives members of military families requiring in-patient treatment, there being no Military Families Hospital. There is a small Military Maternity Hospital, staffed by members of the Q.A.M.F.N.S.

The City Council Laboratory, where a large amount of bacteriological and research work is done, is situated in the town and R.A.M.C. officers have the privilege of working there.

Schools.—There is a small private school for officers' and civilian officials' children, girls up to 18 years of age and boys up to 10 years; it is situated on the Europa Road, near the south end of the station.

The Loretto Convent also takes officers' children.

Speaking generally life at Gibraltar is a very pleasant one. There are ample means of recreation on the Rock itself and access to Spain is easy. One of Gibraltar's chief attractions lies in the fact that it is within four days of home by sea and two and a half days by the overland route; this is a great asset in the eyes of those who have children at school at home.

Quite large numbers of boys and girls come out to Gibraltar for their holidays, and the place is very popular with young people. The P. and O. Company issue special school return tickets at reduced rates, on the production of a certificate from the head of the school concerned.

Social life is quite a gay one; in the winter, dances and dinner-parties, occasional concerts, amateur theatricals, etc., and in the summer, picnics, by road or water, are a great attraction. A car is invaluable, both for getting about the station, shopping and marketing, etc., as well as for getting into Spain. Almost every make of car may now be seen on the Rock; perhaps the most generally useful is a Ford; it stands the Spanish roads well, puts up with a deal of knocking about, and spare parts are easily obtained locally. The car tax is at the rate of £1 per seat. A large number of taxis have recently sprung into existence, and in addition there is the old-established gharry always available for hire.

Sport.—As regards sport the place of honour must be given to the Royal Calpe Hunt. This Hunt dates back to 1814, when it was known as the "Civil Hunt," and the hounds were kennelled at San Roque, six miles away in Spain. In 1817 the name was changed to "Calpe Hunt" and the uniform altered from blue to scarlet. In 1906 the Hunt became a Royal Hunt under the patronage of King Edward VII and King Alfonso of Spain. Hounds are now kennelled at the North Front. The Marquis of Marzales has been Master since 1891. In 1922 the pack had to be destroyed owing

to rabies, and a new pack had to be obtained. One of the officers of the Garrison usually carries out the duties of Field Master, and two or three officers act as whips. Hounds meet twice a week from November to the end of March. Foxes are plentiful. The country is varied, woodland and open hilly ground, with rock and thick scrub; some of the going is very rough. The subscription is £13 a year, with an entrance fee of £2. Officers not belonging to units entitled to subscribe regimentally may hunt five times in the season at 10s. a day cap money. The only units subscribing regimentally are the artillery and infantry.

Although not very much of the country is really galloping ground one quite often gets a fast run; and it is always possible to watch the hounds at work.

The best type of hunter for the Calpe country is the Barb pony, though every breed of horse may be seen out. The nature of the country demands a handy and sure-footed mount, and the Barb meets these requirements well.

Government horses may be hired at a cost of 15s. a month for the hunting season.

Polo is played during the summer months, April to October. The polo grounds are at Campamento, three and a half miles from Gibraltar. Play takes place three days a week. The ponies practically all come from Morocco or Algiers. They are for the most part Barbs with some Arab blood. They can be bought raw in French Morocco and in Algiers for from £15 to £25. Roughly speaking two good raw ponies may be landed in Gibraltar at a cost of £60.

Made ponies sell for from £35 to £50 in Gibraltar.

A certain number of Government ponies are available at a charge of £4 for the season, subject to certain conditions regarding the number of chukkas played.

The cost of keeping horses in Gibraltar is not excessive. Feed costs about £2 10s. a month. A civilian groom's wages are from 20s. to 25s. a month. Shoeing 5s.

There is a good racecourse, the track being a circular one of about a mile. The racing is all flat. Meetings are held throughout the winter and spring months, under the auspices of the Gibraltar Jockey Club. There is also a racecourse at Campamento, where frequent meetings are held under the auspices of the Calpe Turf Club.

Shooting is difficult to get, and one has to go a long way for it.

Sea-fishing claims a large following and sport is good.

Other branches of sport and pastimes are well catered for. There are Rowing Clubs, a Yacht Club and a Swimming Club with its venue at Rosia Bay, where there are spring-boards, chute and high-diving stages.

As regards games, cricket, football and hockey flourish in due season. Cricket is played on matting wickets, which are true and on the fast side. Spiked boots and shoes are not allowed. Rope-soled or crepe-soled boots or shoes are usually worn.

There are excellent lawn-tennis courts of the hard variety, fast and true. The best footwear is rubber or rope-soled shoes without raised heels.

There is a good racquet court and two squash courts.

The Gibraltar Golf Club looks after the interests of that game. The links, nine holes, are at Campamento, three and a half miles from Gibraltar, on the main road to Algeciras.

Most of the sports and games are affiliated to the United Sports Club. Membership of this club includes membership of the Garrison Library and Reading Rooms, and covers subscriptions to all games except polo, for which an extra subscription of five shillings a month during playing months is required. The Gibraltar Yacht Club requires an additional subscription of ten shillings a year. Membership of the United Sports Club also covers admission to all race meetings in Gibraltar, but does not include hunting.

The subscriptions to this club are £7 4s. a year, or £1 16s. a quarter. An officer's wife can join as an honorary member at a subscription of £3 12s. a year, or eighteen shillings a quarter. Thus a married officer's subscription for himself and his wife amounts to £10 16s. a year, or £2 14s. a quarter.

Sports gear can be obtained locally, either from shops in the town or from the N.A.A.F.I. It is as well, however, if one intends to play cricket, to bring out a couple of good bats from home, and tennis players are advised to bring at least one good racquet.

The cost of living at Gibraltar is high. Taken all round food is more expensive than at home. Meat is slightly cheaper but the quality is poor. Fish is good and as a rule easily obtained. Fresh milk is difficult to obtain and is expensive, fivepence to ninepence a pint. Fruit is plentiful and cheap; grapes and melons are particularly good. Groceries are much more expensive than in England. There is, however, a silver lining to every cloud, and whiskey and tobacco are half the price they are at home.

The shops on the whole are poor, but there is a good English tailor, a good saddle and harness shop, and a good chemist. It is advisable to bring out a good supply of stationery and soap. Special soap for use with the sanitary water can be obtained locally.

Furniture can be hired from a local dealer and also from the Ordnance Department, but it is not easy to get just what one requires, and married officers are strongly advised to bring out what furniture they have. English furniture as a rule finds a ready sale here when one is going home.

Mosquito nets are necessary, at any rate for ladies and children, during the summer months. It is advisable to bring them out from home.

Clothes required are much the same as in England, though under-clothing may be of a lighter quality. It can be quite cold in the early months of the year. Morning coat and top hats are not needed. A bowler hat is *de rigueur* for hunting and is also worn at race meetings.

Solar topees are necessary for children during the hot months.

Home pattern service dress uniform is worn from October to April, and khaki drill with tropical helmet during the rest of the year.

Cloth mess dress is worn for most of the year. White mess jackets with white mess waistcoats are sometimes worn, with cloth overalls; this is a matter which is left to commanding officers.

Ladies are advised to bring out a good supply of evening frocks.

Spanish domestic servants are usually easily obtainable. A cook's wages range from £4 to £4 10s. a month, and a house-parlourmaid's from £3 to £3 5s. The majority of these servants talk very little English. Children's nurses are sometimes obtainable, but are few and far between. An officer with young children is advised to bring out a middle-aged English nurse if possible.

It is hoped that this short article may prove of some help to those who find themselves ordered to Gibraltar.

The writer is indebted to Major C. A. Murray, R.A.V.C., for his help in the notes on hunting and polo.

Echoes of the Past.

AN ARMY SURGEON'S EXPERIENCES IN SOUTH AFRICA, 1843-46.

EDITED, AND WITH A FOREWORD, BY H. B. NEWHAM, C.M.G., M.D.
Late Temporary Lieutenant-Colonel, Royal Army Medical Corps.

FOREWORD.

THE letters printed below have recently come into my possession, and as they recount incidents in the life of an Army Surgeon on active service in South Africa some eighty or more years ago, it was felt that possibly their perusal might be of general interest to readers of this Journal.

The letters were addressed to my great-grandfather, Dr. John Cowley, of Winslow, Bucks, or to his son, Dr. George Cowley, and the writer had, previous to his entering the Army, been an assistant in the practice carried on by the father and son at Winslow.

It may be of interest to record that Dr. John Cowley was in practice at this place for an unbroken period of fifty-four years, viz., 1802 to 1856, dying in the latter year at the ripe old age of 78; whilst his son, Dr. George Cowley, pre-deceased him in 1854, falling a victim to the cholera epidemic which ravaged London in that year.

The letters are published almost in their entirety, the only omissions being paragraphs referring to purely personal and domestic matters.

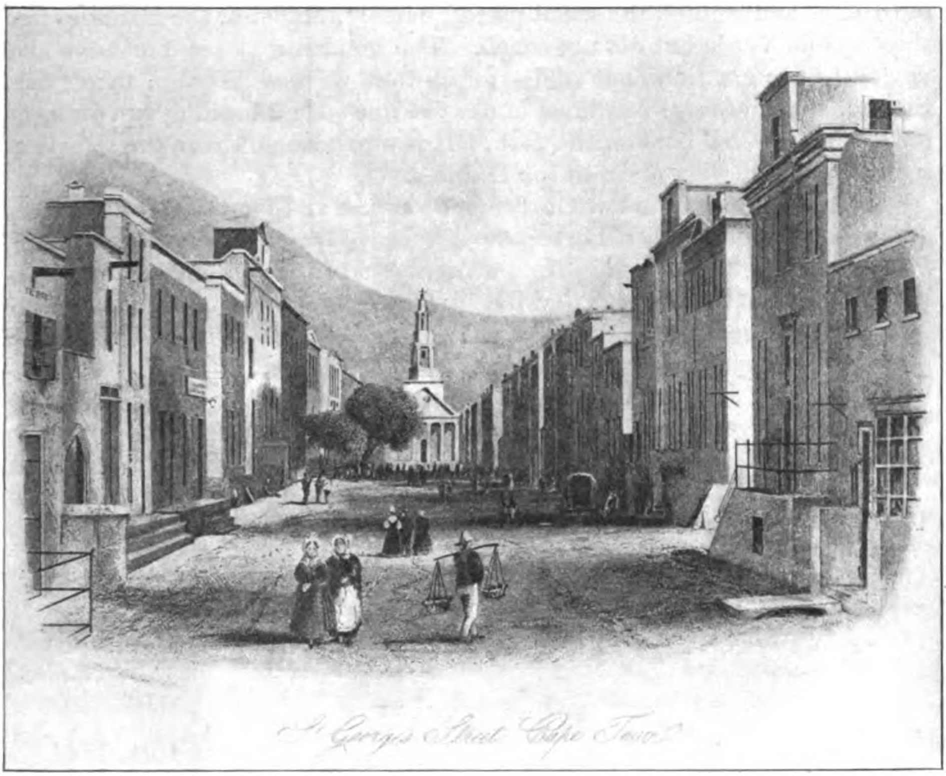
To readers who know Cape Town, it is interesting to compare the picture of St. George Street in 1845, which appeared at the head of one of the letters, with the present fine appearance of that street.

I am greatly indebted to Lieutenant-Colonel MacArthur, D.S.O. R.A.M.C., who has kindly furnished me with some notes concerning the military movements to which the letters refer.

He writes as follows:—

"When Natal became a British possession, large numbers of the Boer inhabitants emigrated, to the great displeasure of the home Government. It was thought that the establishment of a chain of large native states, stretching along the colonial border, would prevent further emigration from British territory, and also that the emigrants, finding themselves, thus cut off and under tribute to native chiefs, would be compelled to return. The plan was put into operation, but resulted in complete failure. The new treaty states became bases for hostile native action against the colonists, who were harried in perpetual raids and forays; over a hundred murders were perpetrated in British territory, and a state of virtual war existed on the colonial frontier. In March, 1846, matters came to a head when a Kaffir, held by the Crown on a charge of theft, was

rescued by his friends, and one of the guard, a British subject, killed. The ruling chief concerned refused to surrender either the rescued prisoner or the rescuers. War broke out in consequence, and a British force invaded Kaffirland. The campaign opened with the usual series of disasters, and the invading troops were forced to retreat. Thereupon hordes of natives poured into the colony, plundering and wasting. All the burgers were called to arms, and every available soldier sent north. The arrangements for supply and transport utterly broke down, and at one period the British Army had to withdraw to the coast. Finally some degree of success was


St. George's Street Cape Town

achieved, and the Seventh Kaffir War ended in 1847 with the pretended submission of the Xosa, the chief native tribe involved. The British regiments concerned in the Seventh Kaffir War were: 7th Dragoon Guards, 1st Battalion Rifle Brigade, the 6th, 27th, 45th, 73rd, and 91st. In addition the 62nd were stopped on their way home from India and the 90th on their way home from Ceylon. Peace was of short duration, and, with the ambushing of a British force by the Xosa, in 1850, the Eighth Kaffir War began. This is most widely remembered to-day by the wreck of the *Birkenhead* while transporting reinforcements from Simon's Bay to Algoa."

Cape Town,
July 1*st*, 1843.

George Cowley, Esq.

My Dear Sir,

As I find a friend starting for England, I write to say that I am now on the point of departure into the interior, about 700 miles, where we are now engaged against the Kaffirs who have been ravaging the eastern part of this Colony. I proceed to Algoa Bay by steamer and thence by land to Fort Beaufort, our present headquarters. We had a long but quiet passage of 81 days and sighted the usual places, namely, Madeira, the Canaries and the Cape de Verde but did not touch. The incidents at sea I cannot give you as I have not time, but suffice to say that we saw Whales, flying fish, Sharks, etc., and were becalmed under the line with a broiling sun for some days. We arrived here on the 25th. It is a handsome town, the streets at right angles and very clean in the Dutch style.

I have been presented at Government House and found old Napier very gracious. I found in Mr. Porter, the Attorney-General, an excellent fellow. I had an introduction to him from a friend. We (Fraser and myself) have been at several parties. They live in the Indian style. The fruits are splendid, oranges, grapes, peaches and a hundred others of which I know nothing. Everything foreign is remarkably dear here.

There is, I believe, here every nation under heaven, Chinese, Kaffirs, Hottentots, negros, and Malays who would astonish our coachmen by driving ten or twelve spirited horses in hand with a whip like a fishing-rod.

Table Mountain, nearly 4,000 feet high, lays almost over the Town. The Bay in this season (winter) is dangerous in the extreme, several vessels being wrecked every season.

Still yours,
(Sgd.) W. N. Irwin.

Fort Peddie,
Cafraria,
March 16*th*, 1844.

My Dear Cowley,

We have at this post a good many people, four Officers with myself. The Commanding Officer is our Major, a good man, nearly an "exquisite," but at the bottom a brick. We live in the same house and pull well together. There are two or three ladies as well, one a Mrs. Wark, lady to Captain Wark, 91st Regiment, an authoress of some note in the annuals and a mild blue. I am her cavalier, servant, and accompany her in riding, walking, and we generally have a song every night. She sings, plays the guitar, dances with the castanets, gives imitations of everybody, and I may say knows every one of title or literary eminence in England, so we manage to make time pass. She has lived when a child with the

Calverts, as her father was Colonel in Sir Harry's old Regiment, the 14th or Buckingham Regiment.

There is a great dearth of young ladies. Of this, however, I care little, indeed I believe it is thus better.

As I mentioned to you before, I like my brothers better every day. We were stationed at Fort Beaufort for some time, together with the 7th Dragoons, and parted from them with regret. They say they never met people they liked so well as ours, and gave fetes and balls to no end before our removal to Grahamstown, our present headquarters. They keep up their hunting of Jackals, the fox of Africa, with their splendid pack, and have had some splendid runs.

. . . .

I live very quietly, take my glass of wine in moderation, ride out my horses, and live quite at my ease, as I have in this post nothing to do but look into my Hospital for five minutes in the morning, as there is hardly any sickness. Look out for the post once a week for English news, which generally comes every ten to twelve weeks, go out and shoot, or read within doors if the weather is too hot to venture out. We are annoyed by hot wind which scorches the grass and has a most unpleasant effect on the nervous system, but is generally succeeded by thunder and rain, which soon clears the atmosphere. This has been the wettest season known here, and the crops, of which there are two in the year, are very fine, this being our autumn.

. . . .

I should be much obliged if you procured the words and music of the Cracovienne and another song Miss King used to sing for me; if it is written small you could enclose it to me. Tell Mrs. Cowley that our ladies are most agreeable and nearly all musical; one, Mrs. Delmege, whose father is an Italian, plays the harp and piano really exquisitely; she is now learning all the Irish songs of Mrs. Crauford's (Kathleen Mavourneen, Dermot Astore, etc.) for me; she is a most amiable and good creature, but the truth is all our ladies spoil me and make quite a sort of brother of me. When I go to headquarters, where the majority of them are, they tease the Colonel for leave that I may stay for a day, and generally succeed.

If I have one more of a chum than another in the Regiment it is McLean, of the Light Company, one of the finest fellows in the Army. My friend, Dr. Fraser, is now stationed at the same outpost with him, and we frequently see one another as it is merely 40 miles off, nothing here.

Kennedy, formerly of the 7th Dragoons, now 18th Royal Irish, who takes this for me, has been with me a good deal, and being a great draughtsman has sketched much in this neighbourhood, and introduced your humble servant into some of them which he threatens to have lithographed when he arrives in London.

. . . .

We expect to go home within two years, and if Delmege, my senior, is not then promoted I will have to be transferred to another corps, as there is but one assistant at home. I think it probable in such case I shall retire from the Service and settle down quietly in some nook in England, if such should turn up, or perhaps go into a cavalry regiment and stay at home; much will of course depend upon circumstances.

I have had a very severe attack of Rheumatism for some days, brought on through my imprudence in jumping out of my bed in pursuit of a wolf, but I am now quite well and as merry as ever, as my effusion will testify. We live right well, get lots of fruit, and except on Sundays I never put on regimentals here. I have learned a little Caffir and amuse myself by practising upon them. They think me a great man, but for some it would be dangerous to practise among them as they dread being bewitched or poisoned, and should anything untoward take place might give the benefit of an assegai, but I am not afraid.

I have had only one fall from a horse since I have been here, and that a slight one, and I assure you some of them puzzle the knowing ones to sit. As I mentioned to you before I have a treasure. I rode him about six months ago 65 miles and cantered all the way. He was next day as clean in the legs as if he had only a moderate canter. He is so varmint as to stand a heavy fire upon him, and I have no doubt of his rushing against fixed bayonets if ridden to them. His former masters cannot bear the sight of him as I had him for a mere song, only he is a gelding I should bring him home with me.

We have just heard that our new Governor, Sir P. Maitland, is on his way out. Sir George Napier is very unpopular and we are delighted to get rid of him.

. . . .

Believe me,
Ever your unchanged,
(Sgd.) W. N. IRWIN.

P.S.—Direct to me as before, and take care of writing 28th for the old 27th Inniskillings. Let me know what you were using for face-ache before I came away. I push the iodine on and succeed well. It stood me well with the Boers. We have a good Library at Grahamstown. How does yours go on?

Fort Peddie, Caffraria,
Southern Africa,
March 16*th*, 1844.

To John Cowley, Esq., Winslow, Buckinghamshire.

MY DEAR SIR,

I received George's letter with the enclosure of the account of the presentation of a salver to you, and I can assure you was not a little pleased and gratified to see such a testimony to the value my dear friends at Winslow attach to your constant and untiring exertions for their happiness and pros-

perity. Having witnessed, as I did for two years, the exercise of those exertions and their success, may you long live and have health and strength to persevere in them is my heart-felt wish. You may, I suppose, fancy that because I am so widely separated from you all and so differently occupied, that I have ceased to be interested in you, but I can assure you that often beside our watch fires in the lonely desert I think and talk of you. I have before written slight sketches of this vast country and its inhabitants, and shall merely glance at present at some other peculiarities. In the first place I am just now attending a great chief of the Caffirs named Umcai, who has been ill for some months, and for whom a man was, according to Caffir law, burned to death a few weeks ago on the charge of bewitching his chief. This is a common occurrence among them. They have their witch doctors for discovering who is the guilty individual and who generally select some one who is rich in cattle and not a favourite with the chief, as in this case all his flock is forfeited and goes to the chief. They will do anything for cattle of which they have enormous herds, and this is the cause of really all the disturbances between them, and as on the Frontier he is counted the best man among them who can steal the most successfully. They are desperate men when roused, but I must say will not take life away wantonly. They have now, thanks to the supineness of former governments, lots of muskets, but their common weapon is the assegai, one of which if I mistake not is in your Museum. They also use shields of thick bullocks' hide. Their war dances are pretty, but at the same time when viewed closely terrific, as they go through all the motions of stabbing and slaying their enemy. They have also dances on marriage occasions. When a young woman is fit to marry and after the purification, when the puny men have been circumcised, which they are about 18 ; those two last are, however, very obscene. Many of their customs resemble the Jewish, but they have no idea of the origin of them, and a very vague notion of a superior being. Although upon extraordinary occasions a sort of offering is made, but to whom or what they know not. They are very superstitious as I nearly know to my cost. A few days ago Captain Kennedy of the 18th Royal Irish, who was here on a visit with his father, the Colonel of the 7th Dragoon Guards, and I were on a shooting excursion to the Keiskamina, within thirty miles of this place, and shot a bird of magnificent plumage called the Caffir Crane. We were surrounded by the natives in a short time to take vengeance on us for killing a bird they held sacred and to whose death they look with great horror, as it is imagined that when this occurs their cattle will die and their wives become sterile. Fortunately for us the English agent with that tribe came up at the time and released us upon my assurance of making good any deaths among the cattle of a neighbouring kraal. He also explained to them that I was a great doctor and could cure any disease, and immediately I was looked upon as a sort of divinity. I had fortunately my lancets with me and used them with some benefit to boils, whitlows, etc., which were presented to me. My present

station where I have been now two months is the best in Africa, and was kindly given me by the Lieutenant Governor, Colonel Hare, formerly of ours, with whom I believe I am a favourite. You ask me how I like soldiering, Well then, it is not the drawing-room life of a soldier in England, but is full of dangers, fatigues and troubles, but then on the other hand there is such a brotherhood among us and a feeling that we are deserving our country old England's thanks, and when together we do enjoy ourselves after fatigues, etc. Where I was before the riding and visiting my outposts was killing, as I had 80 miles of country to traverse, some of the passes through the mountains very dangerous from the acclivities and also from the torrents which rush down their sides. You can never here calculate upon the weather, as you may have this hour a wind so hot as to scorch the grass, and in two hours thunder and rain such as is not known in Europe, and woe-betide you if you have a river in front to cross, as perhaps you are 40 miles from a habitation and your way (not road, for that is unknown) as slippery as ice, the soil being generally very hard and ferruginous it becomes like soap on the top. I have not mentioned the extraordinary performances of the nags here. To a European it is beyond credit, but I fancy I have now about the last thing of the kind on the Frontier which I got for a mere trifle on account of his vice. He is now the admiration of everyone for his beauty and extraordinary gentleness. A bright chestnut, but in figure and size like the Coroner's old grey. The country would delight you in fruits and flowers. The Geraniums grow very large in the hedges, and I often laugh when I think of your cacti in pots on the mantelpiece. Your dining-room would not contain one of the wild ones here. This is our autumn and the heat was about 95 yesterday morning in the shade, although here being near the coast we have a sea breeze. I am within 48 miles of our Headquarters, Grahamstown, the capital of the Frontier. This is the only post absolutely within the Caffir boundary, but the Government have reserved it on account of its position and commanding site. There are numerous Missionaries here who are, I must say, working strenuously and with some apparent success, but they have much to contend with, as men do not readily give up their customs and vices, particularly such as they are. The Caffir men are generally tall and beautifully formed, active and graceful in their movements, their language sweet and pleasing to the ears, and when they speak English it sounds on their tongue like the soft Italian. They are crafty and most subtle in discourse and many of them are extremely eloquent. They weigh your question well before they give an answer, and then you cannot believe them if you are not well acquainted with the modes of cross-examination they themselves practise. The affairs at Natal are gradually settling down, although Major Smith of ours is still there with 400 men, but we soon expect them down. I am extremely happy in my gallant brothers. We are, I have no doubt, the most united corps in the service. Our Colonel Johnson, although strict to the letter on duty, is like an elder

brother to us all, and from him to our last joined ensign, the Hon. Mr. Pakenham, nephew of the Duke of Wellington (whom may God long spare to his country), it is all the same. The Colonel has been staying with me for some days, and I assure you I was quite sorry when he left, so entertaining in his conversation, so elegant in his manners and a scholar and a soldier of the first water, who is aware he commands a corps *secundus nulli.* We expect our relief in about 18 months or 2 years at farthest, when I hope to have the pleasure of talking over old times and drinking a glass of wine with you off the aforesaid salver, when I think you will find me much changed, but not in the heart's memory of your fatherly kindness to me. I have been led to write this long and I fear tiresome epistle, but I had so much to say to you from this strange country. . . . I have made some cash by private practice among the Dutch Boers. I am supplied by Government with rations for myself, fire and light with quarters and forage for two chargers. Provisions, wine, etc., being cheap, we live well and amuse ourselves shooting, riding, etc., and watching for English news, which is one of the greatest excitements we have. Now the Caffirs do not trouble us so much. Our post from Cape Town is once a week and we receive every 2nd month (or 3rd) a mail from home.

Believe me, my very Dear Sir,

Yours gratefully attached,

W. N. Irwin.

P.S.— . . . I have now little to do, five minutes' glance at my Hospital in the morning does all, as I have only one outpost and this place is very healthy, although many of the 7th Dragoons are dying of Dysentery at Fort Beaufort on account of the heat and bad water. The 7th and 27th have been together for some time and we like them very well. This letter is kindly taken by my friend, Captain Kennedy, who is on sick leave home from China, and who stopped on his way to see his Father, the Colonel of the 7th Dragoons.

(*To be continued.*)

Current Literature.

KERR, J. **School Lighting (Modern Requirements and Recent Progress).** *Illuminating Engineer*, 1926, v. 19, 163-5. Also in *Journ. School Hyg. and Physical Education*, 1926, v. 18, 280-84.

In this paper, Dr. James Kerr (late School M.O. for London) traces the progress in hygienic lighting of schools from the time of the appointment of the first joint committee of investigation by the Illuminating Engineering Society in 1911, and compares it with the engineering progress made from the time of the old carbon filament to the half-watt gas-filled electric bulb and modern gas appliances. He re-emphasizes the standard, laid down in 1914, of 0·5 per cent 'daylight-factor' (ratio of illumination in room to that at same time from hemisphere of sky), or 1 per cent. 'sill-ratio' (ratio between illumination in room and that of outside window-sill) in schools.

He recommends for school windows use of glass (e.g., 'vita glass') pervious to ultra-violet rays of 300 to 310 $\mu\mu$ to which is attributed so great a stimulating effect upon nutrition, especially in children. This practical suggestion has the greater force when one considers the intimate relation between light and ophthalmic nutrition in young childhood, and every aid should be given to the industrial cheapening of such glass.

The author's wish to increase the minimum light for any school place from 2 to 3 foot-candles is in accord with the present trend.

His experienced exposition on "Children's Vision" is so instructive that it calls for quotation :—

"The psychology of a child, especially a young child, is to be regarded. Actual school observations show that there is a considerable effort for a child to recognize what it can see. An adult sees the form or shape of an object or words at a glance. The merest hint, and then association with past memories, places the word or object at once. Not so the child; details have to be pieced together to recognize and assimilate or apperceive the whole. For this reason well-illuminated detail is educationally needed, especially the younger the child. It is as if a big voltage were wanted to carry the nervous impress over the resistances in the slightly developed nervous tracts of the child, otherwise the intellect is not reached, and recognition not attained."

That refers to children with normal vision, and good illumination is of even greater importance with those—variously estimated at from 2½ to 5 million of the children in Great Britain—whose vision is defective. It remains to be seen to what extent improved lighting in schools will lessen the present disastrous proportion of 66 per cent of industrial workers suffering from some defect of vision, but the main experiment is one urgently demanding trial.

Dr. Kerr's wide experience lends weight to his view that minimum lighting standards now in use should be doubled if study is carried out for extended periods. Later experiments suggest that the 5 to 7 foot candles which he advocates as the need for desk-tops should be further increased to at least 10, and that the optimum may be even as high as 20. This increase adds the greater force to the necessity, which Dr. Kerr urges, that "all naked sources of light should be shaded or screened," and that "no visible source of illumination should exceed 3 candles per square inch in intrinsic brilliance." He stresses the need of 60 per cent accessory illumination upon the surface of blackboards, which play so important a part in modern class-teaching.

While Dr. Kerr himself was much impressed by the results obtained from 150-watt Mazda lamps in 16-inch globes (of which six in a room of 28 by 32 feet gave 5 foot-candles on a consumption of 1 watt per sq. foot surface), the subsequent discussion gave the impression that the more general opinion was in favour of the 'restlight' principle of filtering off the excess of orange-red rays which are present in ordinary electric light to the extent of 4½ times the proportion in the daylight spectrum.

P. S. LELEAN.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 12.

HINDHEDE, M. **The Biological Value of Bread Protein.** *Biochem. J.*, 1926, v. 20, 330-34. [4 refs.]

MARTIN and ROBISON published a paper in 1922 in which they stated that the protein of bread has a biological value of only 30 to 35 per cent of that of animal protein. The author of this paper has investigated the question himself and has found bread protein to be equal in value to animal protein. He has obtained nitrogen equilibrium in men receiving 22 grams of digestible bread protein a day, which is about the minimum quantity of of meat protein necessary to maintain nitrogen equilibrium. He has found it necessary to continue the low protein diet for many weeks before the equilibrium is established, and it was apparently neglect of this procedure which led to the failure of MARTIN and ROBISON to obtain equilibrium on their low bread protein diets. When bread is the main item in the diet it is very difficult to reduce the nitrogen intake to a very low level without reducing the caloric value of the diet below the requirements of the body, on account of the relative richness of bread in nitrogen. This difficulty can be overcome by adding large quantities of fruit, which has been found to reduce the absorption of nitrogenous compounds. There is evidence that the quantity of nitrogen absorbed from such fruit as strawberries is almost negligible. Young men remain in good health and capable of doing a hard day's work for months on end while taking a diet containing only this small amount of protein of vegetable origin.

E. MELLANBY.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 12.

HUDDLESTON, J. H. **Foods and Deficiency Diseases in War.** *Milit. Surgeon*, 1926, v. 58, 510-23. [25 refs.]

Great attention was paid to nutrition problems during the Great War. The Inter-Allied Scientific Food Commission, composed of experts from the various allied nations, made it its business to acquaint the nations concerned with any scientific knowledge that might be useful in allocating food supplies. In America there was a United States Food Administration Department whose duty it was to advise the civil population as to methods of balancing their diets and economizing in food. A special Food Division of the Surgeon-General's office was established for the supervision of the rationing of the United States Army. All these bodies devoted their attention to research into practical problems of nutrition, and this paper embodies some of the conclusions which were reached.

For soldiers not on active service a minimum ration of 3,300 calories was advised; a ration of 3,900 calories should be given to troops on active service. Growing youths should be supplied with extra food beyond this allowance. Exposure of troops to cold and wet raises their food requirements. Health can be maintained on a far smaller ration if heavy work is not done; a large proportion of the civil population of Belgium lived entirely on the ration supplied by the Commission for Relief in Belgium and this never exceeded 2,000 calories. "War bread" presented difficulties; too much germ in the flour impaired the keeping qualities of the bread; too much bran made breadmaking difficult for the inexperienced. If loaves are not too big and are baked with a very hard crust they are not so liable to get mouldy. The Hoover Commission in Belgium demonstrated that men could subsist without showing signs of deficiency diseases on diets containing as little as 35 gm. of protein a day. The problem of the minimum and optimum ration of fat was never solved. A certain amount of knowledge concerning the keeping qualities of vitamins was obtained during the war. The value of tinned tomatoes as a source of vitamin C and even of B and A was recognized and the antiscorbutic value of germinated pulses was worked out. Not much fresh knowledge of food deficiency diseases was obtained from war experience, but ample opportunity was given to demonstrate the value of the previously recognized methods of treating beriberi and scurvy. Studies of the ætiology of pellagra were undertaken and attempts were made to place the disease in the category of a deficiency disease. Though evidence was obtained that the eating of maize was in some way implicated, the problem was never solved.

E. MELLANBY.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 12.

Reviews.

Malta Effulgens. Containing articles on the history of Malta. By Major M. B. H. Ritchie, D.S.O., R.A.M.C. Printed at the office of the *Daily Malta Chronicle*.

There are probably many senior and retired officers who have served in Malta in the past, whose happy recollections of this, in many respects, delightful station, will be aroused by a perusal of this bright little brochure. Younger officers also to whom service in Malta may be a not unlikely prospect for the future will be interested in the eight informative pages collected together under the title of "Melita Effulgens."

In the first article the author gives a brief general description of the island, and a preliminary sketch of its history since the Phœnicians first went there in 1400 B.C.

The second article is devoted to the history of Valetta from the date of its foundation in March, 1566, and the early association of the Knights of the Order of St. John of Jerusalem with the island.

The third paper gives an account of Malta and the culture of the Knights in 1770, as observed and recorded by an English traveller named Brydone who visited the island in that year.

The succeeding papers recount in more detail the history—naval, military and political activities—of the Order, not only in Malta, but throughout the Mediterranean area.

The final, and perhaps the most interesting, chapter treats of events in Malta from 1798 to 1800, viz., the last phase of the occupation of the island by the Knights of the Order of St. John of Jerusalem, the capture and occupation of the stronghold by Napoleon on his way to the conquest of Egypt, the revolt of the Maltese against the French after the Battle of the Nile, and the timely assistance sent to the rebels by Nelson, his subsequent arrival on the island, followed by the overthrow of the Napoleonic régime, and the final events which led to the conquest of the island by the British.

The brochure concludes with a "Glimpse of Ancient Syracuse," and an account of an "Ascent of Mount Etna."

The Carrier Problem. By K. G. Paul, M.B., B.S., with Foreword by David Nabarro, M.D., F.R.C.P. Oxford University Press. Humphrey Milford. 1926. Pp. xii+102. Price 5s.

The detection and treatment of carriers of infectious diseases is a problem that frequently perplexes army medical officers, and especially concerns those who are experts in hygiene and pathology.

So far as we are aware no authoritative book on the subject has been produced in England since the publication, some fourteen years ago, of Ledingham and Arkwright's exhaustive treatise on the "Carrier Problem in Infectious Diseases." We, therefore, welcome Dr. Paul's essay, which, though somewhat elementary, gives us in the space of 93 pages a lucid and concise summary of what is now considered to be essential knowledge with regard to carriers of common infectious diseases, and the measures that should be adopted for their identification and treatment.

A frontispiece illustrates diagrammatically by means of an ingenious chart the relation of the carrier rate to the rise and fall of epidemics of infectious disease that may be present in a community.

The author classifies carriers into contact carriers and convalescent carriers, each group is subdivided into temporary and chronic.

Carriers of the following special diseases, enteric, diphtheria, meningococcal, pneumococcal and streptococcal infections, acute poliomyelitis, bacillary dysentery, cholera and entamœba hystolytica are dealt with in separate chapters, each of which is followed by a bibliography of the subject therein treated.

In the chapter on typhoid and paratyphoid fevers, McKendrick's skin reaction test and the autolysate-precipitin reaction, designed for the detection of carriers are described, and in an excellent chapter on carriers in acute poliomyelitis the author briefly reviews all that is known regarding the part played by carriers in the spread of this disease.

A full index is given and the book is conveniently arranged for ready reference.

We recommend this little book as a most useful addition to the library of medical officers of the fighting services.

Diagnosis and Treatment of Venereal Diseases in General Practice. By L. W. Harrison. Humphrey Milford, Oxford University Press. 1926. Pp. xv + 558. Price 25s. net.

Since it was first published in 1918, this book has run to three editions, and the present one is a revised second impression of the third edition. Colonel L. W. Harrison's book has been deservedly popular and is to be regarded as an eminently sound exposition of the whole subject.

The work, comprising some 558 pages, including an excellent index, is arranged in twenty-three chapters and eight appendices. There are eighty-three illustrations and nineteen coloured plates. The subject of venereal diseases is discussed throughout in a thoroughly practical manner by one who is an expert in every branch of the subject. The author's initial interest in this subject lay in the serological and purely laboratory side of the problem, and he was one of the pioneers in standardizing the serological test. Since those days, his work has been on the clinical and administrative side, and there can be few who have had such vast ex-

perience of these diseases in all their variations, and under all conditions, so that the subject matter is the result of keen observation and practical experience by one who knows the subject from A to Z, not only in theory, but in practice. The reader will observe throughout the book that no theory is stressed simply for the sake of a theory, but only when supported by the undisputed confirmatory facts.

The same remarks apply to treatment; all the ways and means and actual lines of treatment recommended are supported by actual experience based on therapeutic results. The present edition has been thoroughly revised, brought up to date, and in parts re-written. In addition, the following new features are introduced for the first time, viz., a general description of the complement-fixation test for the serum, and the gold test for cerebro-spinal fluid.

We have no hesitation in again recommending the book as a thoroughly up-to-date treatise on this subject, both for general practitioners and for those specially interested.

The letterpress is excellent, and the book so well put together that it is easy to read. E. C. L.

THE SURGERY OF GASTRO-DUODENAL ULCERATION. By Professor Charles A. Pannett, of St. Mary's Hospital, London. First edition. Oxford Medical Publication. London: Humphrey Milford. 1926. Pp. x + 154. Price 10s. 6d.

The author explains in his introduction that this short account is not intended as an exhaustive treatise, but is written to present to the reader some of the surgical problems with which the subject bristles.

When it is remembered how often the various aspects of the subject are discussed in the current medical press, with here an advocate of palliative treatment, and there a ruthless exponent of the total-extirpation policy, it must be confessed that one tends to weary of reading the subject, more especially as we are still in complete ignorance of its causation. It is handy to have a well turned out and well illustrated book like this, and to be able to scrap all one's old cuttings.

As for symptomatology, there is nothing new. Except in cases where there is a likelihood of malignant disease, the test meal is of little value.

Gastric ulcers are best treated by medical means; those which are intractable are usually near the cardia, and thus almost impossible to deal with surgically. The American view that malignancy often *follows* gastric ulceration is not confirmed in the experience of Professor Pannett.

For pyloric stenosis, and when the ulcer is in the pyloric antrum, gastro-jejunostomy gives good results. This procedure, combined with incision or cauterization (Balfour), gives the best results for other types of gastric ulcer.

Sleeve resection should be confined to those who are constantly doing

such work, and in any case only in suitable cases. Gastric digestion is always interfered with.

The results of posterior gastro-jejunostomy for duodenal ulcer can hardly be improved upon at present.

The book concludes with interesting chapters on complications, operative technique, and post-operative complications. This handy little volume is confidently recommended to all who are specially interested in the subject. D. C. M.

Notice.

RE-OPENING OF THE WELLCOME BUREAU OF SCIENTIFIC RESEARCH.

THE Bureau of Scientific Research was founded in 1913 by Mr. H. S. Wellcome; it is housed in Endsleigh Gardens, London, and Dr. C. M. Wenyon is now the Director-in-Chief.

The Bureau buildings have recently been reconstructed and enlarged. The laboratory facilities for research are now greatly increased, and additional halls have been provided for the new exhibits of the Museum of Medical Science. There are twelve well-equipped laboratories and also an art studio, a photographic department, animal houses, and various preparation rooms.

Routine teaching is not undertaken, but individual workers who wish to follow any particular line of investigation are given accommodation and helped in their studies. The Bureau also supplies information to medical men, health officers and others interested.

On December 8, Mr. Chamberlain, the Minister of Health, re-opened the Bureau and Museum, and in his speech alluded to the rapid spread of knowledge from one part of the world to another. The Museum, he said, was of unique and remarkable character; the method of instruction was pictorial, and the drawings, paintings, photographs, models and specimens made a very impressive picture which could not be excelled by any other method of demonstration. The Museum dealt, not only with diseases of temperate climates, but also with those of the tropics and showed their causes, symptoms, treatment and prevention in a most complete manner. Mr. Wellcome had done a great public service in making available this epitome of all that science has hitherto achieved in this sphere of work.

Sir Walter Fletcher, Secretary of the Medical Research Council, then delivered an address on "Research and Citizenship." To his mind the special interest of the Wellcome organization was its origin and the particular mode of its financial support. Scientific research in this and other

countries depended during the past, not on support given to it by the general community, but upon the accidents of the distribution of wealth, upon private patronage, the endowments of universities, and sometimes upon the personal possession of wealth by the investigator. In the first quarter of the present century there had been great changes; business firms now realized that their very existence depended upon the progressive work of discovery and its application. A few firms had adopted the plan of supporting scientific research and leaving their workers as free to follow their own line and publish the results of their work as men in any university laboratory. The Wellcome Bureau and laboratories were supported under this system and the firm might take legitmate pride in the results given to the world. Sir Walter Fletcher described the Museum and Library as forming together a sumptuously illustrated textbook. A former Minister of the Crown, now in high administrative office overseas, had told him that a visit paid to the Museum had given him his first really vivid impression of what scientific work had done and might still do for the peoples of our Empire. It ought to be the proper part of citizenship to understand something of the difficult path the investigator had to follow and to see something of the processes by which a discovery came into practical application. Such knowledge was made easy of reach by the Wellcome Museum. Material benefits did not form the highest gain received by the pursuit of natural knowledge. The work of the Bureau, Laboratories and Museum was twofold—that of increasing "God's honour and bettering man's estate."

At the conclusion of the address Sir John Rose Bradford proposed a vote of thanks to Mr. Chamberlain and Sir Walter Fletcher, and Sir James Kingston Fowler proposed a vote of thanks to the Founder, which, in the absence of Mr. Wellcome, was acknowledged by Dr. Wenyon.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

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The Committee has sanctioned the publication of correspondence on matters of interest to the Corps, and of articles of a non-scientific character under a nom-de-plume. These communications must, however, be approved by the Editor before publication.

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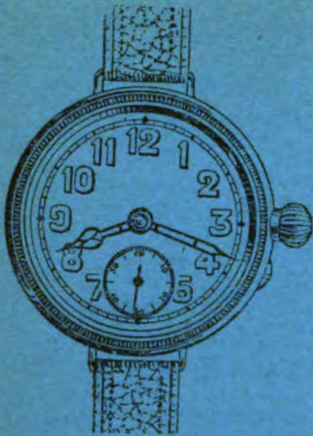

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Journal
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Original Communications.

A PRELIMINARY REPORT ON THE EMPLOYMENT OF CERTAIN CONSTITUENTS OF THE GONOCOCCUS IN THE TREATMENT OF GONORRHŒA AND OF OTHER CONSTITUENTS IN TESTS OF CURE.

BY MAJOR E. C. LAMBKIN, D.S.O.
Royal Army Medical Corps.

MAJOR LYN. DIMOND.
Royal Army Medical Corps.

AND

CAPTAIN W. J. ROBERTSON.
Royal Army Medical Corps.

THIS Report deals with investigations carried out at the Royal Herbert Hospital, Woolwich, during the past year, in the treatment of gonorrhœa on somewhat novel lines.

The investigation is not complete and no extravagant claims are made for the ultimate success of such methods of treating this disease, but it breaks fresh ground in vaccine therapy and may stimulate ideas in other workers throughout the Corps.

In this preliminary account of the work technical detail has been eliminated as far as possible, and only the rough outline of the underlying principles has been set forth. It is hoped later to give a detailed account of the investigations.

The theory underlying this line of treatment is the direct result of the researches of Major Lyn. Dimond, R.A.M.C., in the chemistry and biology of the gonococcus, at which he has been working for the last three years.

Speaking generally, it is an attempt at intensive vaccine therapy in the treatment of gonorrhœa.

The treatment of gonorrhœa by the introduction of bactericidal agents into the urethra has had a prolonged trial, and the results have been very disappointing. The failure of this method to cure the condition can hardly be a matter of wonder to any one who is acquainted with the structure of the urethra and the biology of the gonococcus, or who has ever observed an acute gonorrhœal urethritis through a urethroscope. Examination reveals an intense inflammation and suggests that the local application of anything but the mildest and most soothing remedies is contra-indicated.

Throughout this investigation urethral antiseptics have been introduced merely with the object of draining the urethra, and this fundamental surgical principle has been carried out by means of very weak potassium permanganate of 1 in 20,000 strength.

Thorough drainage is essential, and the natural and only reservoir from which efficient drainage can be effected is the bladder. Therefore posterior irrigation is the only method employed.

Gonococcal vaccine therapy has at best given only moderately good results. The main difficulty is the toxicity of gonococcal vaccines due to the liberation of endotoxin by the autolysis of the gonococcal bodies.

The idea underlying this investigation was to find a non-toxic gonococcal vaccine for use: (*a*) Intra-urethrally as a local immunizing agent, as applied by Besredka in other conditions, and (*b*) for general use to be applied either intradermally, subcutaneously, intramuscularly or intravenously.

The task which we set ourselves may be summarized as follows:—

(1) To test the value in treatment of certain fractions or products of metabolism of the gonococcus employed locally and intradermally.

(2) Similarly, to test the value of these fractions or products of metabolism as provocative agents in deciding the question of cure.

(3) Having determined, (*a*) the conditions under which the gonococcus elaborates only antigenic or immunizing properties, and (*b*) those conditions under which it elaborates only toxic properties and develops resistance forms. To test the value of chemical treatment designed to put the gonococci in the patient's tissues under the least favourable conditions of vitality.

By special cultural methods, which are described at the end of this report, it was found that, when gonococci are grown on a medium which, broadly speaking, is rich in animal nucleo-protein, approximately one-third of the isolated strains develop polar bodies (Babes' bodies), which can be demonstrated histologically by staining methods identical with those employed in the demonstration of the polar bodies in *Bacillus diphtheriæ*. These polar bodies are composed of alpha nucleo-protein and beta nucleo-histone.

They are only loosely attached to the bodies of the gonococci, and can be separated easily from these by washing off the culture with two per cent saline and fractionally centrifugalizing the emulsion, or by means of gravity; the polar bodies are then found in the supernatant fluid. Since this two per cent saline solution dissolves the beta nucleo-histone, the solid elements in the supernatant fluid are the alpha nucleo-protein fraction of the polar bodies. Clinical experiments have shown that both the alpha nucleo-protein and the beta nucleo-histone are antigenic (the beta nucleo-histone more so than alpha nucleo-protein) and relatively non-toxic, so that they appear eminently suitable for use in the vaccine treatment of gonorrhœa.

For intradermal, subcutaneous, intramuscular or intravenous injection we employ them in a strength which represents the product of 1,000 million gonococci per cubic centimetre in two per cent salt.

For intra-urethral injection we standardize them in two per cent saline, so that the nucleo-protein of 100,000 million organisms is contained in fifteen cubic centimetres. We prefer to employ much larger doses than this, and better results are obtained with three- and four-fold this dosage, but such large doses are limited by the corresponding large amount of antigen which must necessarily be grown. To this fifteen cubic centimetres representing, say, the product of 100,000 million gonococci, is added one per cent. of sodium taurocholate and the reaction brought to a pH of 7·2; mucin (either commercial or from umbilical cords) is then added to 100 cubic centimetres. The dose is twenty cubic centimetres for intra-urethral injection, or the product of 20,000 million gonococci.

At first we reduced the strength of the suspending and dissolving saline to one per cent by dilution with normal saline, but have more recently employed the alpha nucleo-protein precipitate and beta nucleo-histone solution in the original two per cent saline. This does not cause tissue reaction, and has the advantage that it maintains the alpha nucleo-protein fraction in the solid form and prevents the formation of a small amount of toxin from the dissolved alpha nucleo-protein, thus permitting the employment of the product in larger doses.

So far as our work has gone it has shown that the antigenic properties of a gonococcal vaccine are practically all contained in the alpha nucleo-protein and beta nucleo-histone components of the polar bodies, and that the remainder of the gonococcal body is undesirable for use in immunization.

In view of the observation of various workers that ordinary gonococcal vaccines seem to vary in antigenic value, it is interesting to note that only one-third of the strains we have isolated have produced the antigenic polar bodies.

We have so far employed our vaccine in the following way: The patient is first irrigated thoroughly with a weak solution of potassium permanganate (strength 1 in 20,000), and then twenty cubic centimetres of

the vaccine in mucin and taurocholate of soda are injected into the urethra, precautions being taken to secure that the vaccine is retained within the urethra for as many hours (three or more) as possible.

At the same time the patient receives an intradermal and subcutaneous or intramuscular injection of 0·2 cubic centimetre of the exotoxin vaccine corresponding to 200 millions of the original culture.

The general treatment of the patient is based on the result of observations of the conditions which are favourable to the production of the antigenic polar bodies and those favourable to the production of toxin.

The discussion of these observations need not be detailed here, but generally they showed that the most favourable reaction of the tissues from the point of view of resisting gonococcal invasion is when the pH value of the urine is within the limits of 7·2 and 7·4.

When the urine is on the acid side of this figure, the many gonococci in the secretion are in tetrad formation protected by great amounts of scleroprotein, and as such in resistance formation; on the other hand, when the urine is on the alkaline side, there is considerable autolysis with liberation of irritative endotoxin. After testing a number of alkalies to obtain the optimum reaction of the urine, we found that disodium monohydrogen phosphate appeared to serve the purpose most suitably.

The administration of this alkali is controlled by a daily titration of the patient's urine. After the first injections daily observations are made of the urethral discharge, and the intra-urethral, intradermal, subcutaneous or intramuscular injections are repeated according to various circumstances.

In the case of the intradermal, subcutaneous or intramuscular injections, usually there is a ten-day interval between injections. In the case of intra-urethral injections, they are usually repeated daily should the urethral discharge still show gonococci. Of late our practice has been to raise the initial dosage of this injection and to administer at less frequent intervals.

Again, when a patient's urine reaches the optimum pH value, after being acid when he received his initial injection, it is another indication for a repeated intra-urethral injection. A patient whose latent gonorrhœa is deliberately provoked into activity by the injection of endotoxin as a test for cure receives another intra-urethral non-toxic injection as soon as this latent condition is recognized. Lastly, in the subacute and chronic stages, whenever positive gonococcal discharges are observed, the intra-urethral injections are repeated.

We do not hold that the dosage and intervals which we have mentioned are the best. Indeed, we think that possibly we may be able to administer much larger doses, since, by employing two per cent saline throughout, we have practically eliminated the formation of toxin in the vaccine. We have frequently employed such doses as correspond to 250,000 million of the organism with promising results and no signs of provocation, but so far the difficulty of producing sufficiently large amounts of the vaccine has not permitted our using it in such large doses or more frequently.

The results of the treatment we have carried out on these lines have been various, and we cannot do better than relate the course of events in favourable and in unfavourable cases. In cases which progress favourably the usual course is as follows: After an injection intra-urethrally of twenty cubic centimetres of the vaccine, the discharge rapidly diminishes with a corresponding decrease in the numbers of gonococci in films. The case goes on uninterruptedly to cure, and subsequent provocative instillations of endotoxin fail to cause relapse.

So far as we have been able to determine, this happy sequence of events is the common course taken by two classes of case:—

(1) The early anterior urethritis.

(2) The cases with previous history of gonorrhœa, but who have seen no signs for, sometimes, years, and who have recently been exposed to infection; in fact, as far as one can determine, a reinfection.

Our theory as to the probable course of events is that:—

(1) In an early case it would appear that the gonococci are caught before they have had time to bury themselves deeply in follicles, and that the local and general immunity response is great enough to protect the urethra from spread of infection. The examination of the urethra later fails to reveal the local foci or infiltrations, and there is no involvement of the posterior urethra.

(2) In the reinfected case, one here assumes that the old urethritis denuded the urethra of most of its luxuriant columnar epithelium, which is such a good medium for gonococcal growth, and that the remaining portions invaded by the second attack are more easily reached and reacted upon by the local vaccine, and rapid resolution takes place; in short, the gonococcus is more vulnerable in such cases, although this idea is contrary to the opinion of such an expert as Luys. One must, however, not neglect the fact that in these cases there may be a factor of some degree of acquired general immunity.

In cases which have not pursued such a favourable course, it is very difficult to find some common factor, and it is more convenient to discuss the types that one has noted clinically.

The usual course is an initial amelioration of all signs and symptoms, as in the favourable type of case. This naturally leads to great hopes.

However, somewhere about the tenth to fourteenth day a discharge again appears, showing scanty gonococci in about half the cases. In the majority of cases this is never more than a subacute phenomenon, and the case soon settles down and proceeds as in the more favourable type.

In others this exacerbation may be more prolonged, and symptoms arise which vary from a mild degree of irritation of the posterior urethra

to a severe frank posterior urethritis. Between the two extremes one finds all degrees of severity.

The time of resolution varies according to the severity; a feature common to all is the difficulty of finding gonococci in urethral smears and, having found them, the impossibility of growing them.

We have tried to interpret the course of events as follows:—

(1) In the milder cases the infection remains anterior, and most of the gonococci are dealt with by the initial vaccine application, but some penetrate follicles and remain there untouched by the superficial immunizing process; they, however, get into the urethra again about the tenth to fourteenth day, and it may depend on the condition of the urethra as to whether or not they make subsequent headway there.

(2) A condition of inflammatory œdema may exist at the time of the initial treatment, and the vaccine never gets into contact with the gonococci, except in isolated less inflamed parts. In such cases there always remain resistant foci, constituting a chronic folliculitis, but infiltrations are never encountered to such degrees as one is accustomed to see in these cases. The same condition may be present behind the compressor muscle, with the involvement of the accessory glands. It is in such cases that one has to rely on the intradermal, subcutaneous, or intramuscular route of administration for the stimulation of the necessary antigenic substances.

We are conscious that this is a very sketchy synopsis of cases. The results of treatment of a few hundred cases, when dealing with a disease such as this, are of little value when trying to draw conclusions. The burning question from the Army point of view is "days in hospital." So far this side of the question has not influenced us, as we have been trying to learn and find out optimum conditions and dosage.

The points that have impressed us are that, speaking broadly, we are conscious of a general and sustained improvement in the cases as a whole.

In a large clinic such as this, the daily observations of urethral smears point to an enormous decrease in the number showing gonococci, the urethral discharge quickly becomes scanty, and symptoms ameliorate with almost astonishing rapidity in favourable cases. The incidence of complications such as epididymitis, severer forms of prostatitis, arthritis, etc., has fallen, and the fact that cases so treated have not relapsed has been a most encouraging sign and given us hope that we might be on the right lines towards initiating a line of investigation which would cure what has been an incurable disease.

Certain lessons seem to emerge from our results:—

(1) The importance of stabilizing the patient's reaction by daily observation of his urine pH. Speaking generally, a constantly acid urine indicates the optimum condition for resistance forms

of gonococci and the manufacture of deep-seated encysted foci, either in follicles or in any of the urethral annexes. On the other hand, a continuously highly alkaline urine of pH 8 in many cases will produce an acute posterior urethritis and all its potentialities.

(2) The washing off the culture must be carried out with 2 per cent saline. At an earlier stage the use of serum for washing off the culture and suspension of the nucleo-proteins had the disadvantage of liberating toxin from the protein element of the nucleo-protein and thus causing irritation. The use of serum for this purpose had the further disadvantage that it was difficult to supply the large quantities required for the purpose.

It will be realized from the above that we are far from having elaborated a perfect line of treatment, but we think that some of our results have been sufficiently good to indicate that in immunization by the alpha nucleo-protein and the beta nucleo-histone components alone, eliminating the toxic element, we have a method of treatment which is worthy of further investigation. We have ventured to publish the method at this comparatively early stage because the principle we have expounded seems to open out a new line of attack on gonorrhœa, and because we hope that others may perhaps be inclined to pursue the investigation on similar lines, so that we may attain the long-desired control of gonococcal infection more quickly than would be possible by our working alone with our somewhat limited facilities and material.

A special caution is necessary here. Unless very careful precautions are taken, it is easy to make a vaccine which is not only poor in antigen but highly toxic and irritative, so that we would ask workers to identify carefully their samples. Otherwise we fear that the method, or perhaps the principle of our treatment, may suffer undeserved discredit.

The Use of Endotoxin as a Test of Cure.

For the preparation of endotoxin we have used strains which do not throw out the polar bodies employed in our vaccine. These strains comprise 66 per cent. of those we have isolated.

They are grown for ten days on a special alkaline autolysate of ox heart. The details will be described later.

The culture is washed off, and after being repeatedly frozen and thawed yields a product of albumoses in a blue opalescent solution. It is made up to a strength representing the product of 250 million gonococci in one cubic centimetre, the diluent being chemically prepared colloidal silver.

The effect of an intra urethral injection of this preparation in a quiescent gonococcus carrier is to provoke a temporary activity with the appearance of gonococci in the urethral discharge.

This product we believe to contain the true toxic elements of the gonococcus.

We have employed it for nearly four years now as a routine test of cure before a patient is discharged from hospital. The provocative effect may be observed as early as twelve hours, or may be delayed for several days. We have seen it delayed for as long as a week, and to legislate for these delayed reactions we observe the patient for seven days after an injection of endotoxin before we pronounce him free from active signs.

The great majority of cases, when once provoked by endotoxin, seem to do much better after the "flare up" of their disease; at least, it is rarely necessary to have to give three or four injections of endotoxin at the end of observation periods for test of cure. This fact has induced us to administer endotoxin earlier in the course of treatment, not so much as a test of cure but to provoke the possible deeper submucous foci into activity and cause them to discharge their contents which might, in the ordinary course, become sealed up or encysted, only to break down and empty their infective contents into the urethra later and thus prolong the proceedings.

In certain types of cases this early provocation with endotoxin has been successful, but as a routine it is a risky business under three weeks from the onset of the attack, and we have observed it plunge a case that was doing very well under our routine treatment into a prolonged "negative phase" and cause, in a few instances, a posterior urethritis.

This condition of "negative phase" we had never observed after endotoxin injections employed as a test of cure, but it is a likely possibility if an attempt is made to "hurry things along a bit" without carefully selecting suitable cases.

After any observed provocation following an endotoxin injection the special intra-urethral vaccine is at once injected.

There has been much previous work by various observers which seems to point to the nucleo-proteins as containing or being in some way connected with antigen, or the immunizing complexes. For instance, Sidney Rowland's plague vaccine consisted of the nucleo-proteins extracted from the *Bacillus pestis*.

Major Dimond, at Rochester Row, in 1922, extracted the nucleo-protein from a considerable bulk of gonococcus culture and found it to be very highly antigenic, both by its action when injected into the urethra in acute gonorrhœa, and also when injected intraperitoneally into mice four days before 2 M.L.D. of living gonococcus culture were administered, no obvious action upon the health of the animal being produced. It also caused the formation of amboceptor in high titre when injected into rabbits.

In the case of other organisms a multitude of observers, and in the case of the gonococcus, Vannod, of Berne, have all given satisfactory experimental evidence of the high antigenic value of the germ nucleo-protein fraction.

Unfortunately, all the samples of nucleo-protein so obtained were toxic, due to the admixture of the nucleo-protein with endotoxin; and the small amount (some five to ten per cent of the dry weight of the organism) made

its isolation in large bulk for therapeutic purposes impracticable. Later, at Woolwich, it was found that the gonococcus, when grown on media containing animal nucleic acid and protamines or histones, developed an extraordinary increased amount of nucleo-protein in approximately thirty-three per cent of all strains examined up to date, this increased nucleo-protein content being evidenced, as referred to above, by the presence of polar bodies. As the result of the presence of these "polar bodies," the nucleo-protein content of the cultures was found to be from fifty to fifty-five per cent of the dried weight of the organism instead of five to ten per cent found in cultures grown on ordinary media. In order to stimulate further this nucleo-protein content, all the animal and plant nucleic acids available were tried, and as a result it was found possible to stimulate 100 per cent production of polar bodies in the case of the gonococcus with animal nucleic acid alone. Again, a good deal of attention has lately been drawn to the soluble products of bacterial metabolism in normal saline as a result of Horder and Ferry's investigations. Knowing the small nucleo-protein content of practically all organisms and the peculiar solubility of nucleo-proteins, it seems likely that the antigenic value of such washes deprived of the bodies of the organisms is due to their content of dissolved alpha nucleo-protein.

The following observations seem to indicate that any antigenic action possessed by these germ nucleo-proteins is more an expression of simple nucleic acid chemistry than of any specific origin. Wooldridge, for example, was able to produce immunity to anthrax in rabbits by means of thymus alpha nucleo-protein. We have also noted that mice that had received twenty milligrammes of dried rabbit thymus intraperitoneally, when inoculated four days later with 2 M.L.D. of living gonococcus, survive without illness, as they do when the specific gonococcal nucleo-proteins are used.

Lastly, when considering the remarkable antigenic powers of Calmette's tuberculin which are reported, it seems likely, if our own results turn out to be substantiated, that these reported results are true and that he is employing a vaccine in which he has stimulated nucleo-protein production. The media which he employs for growing the tubercle bacillus for the preparation of tuberculin is one which contains ox bile, and it is probable that its antigenic powers are due to the fact that ox bile has the true mucin found in human bile replaced by a nucleo-pretein, and that a considerable percentage of this nucleo-protein is present.

Cultural Methods.

For the production of these products of gonococcal metabolism there are three separate types of culture media employed:—

No. 1.—*An isolation medium*, details of which are given below.

Strains are isolated, grown and then transferred to medium No. 2, which is essentially the same medium as No. 1, but specially enriched by animal

nucleic acid compounds to stimulate the production of gonococcal nucleo-protein in the development of polar or Babes' bodies. Approximately one-third of all strains isolated at Woolwich were induced by such cultural methods to form these polar bodies—strains constituting the remaining two-thirds did not develop polar bodies. Polar bodies can be demonstrated after twenty hours' culture by staining with Neisser's stain, toludin blue, methyl green, or cresylecht violet. So slight is the attachment of these polar bodies to the bodies of the gonococci, that even in a heat-fixed film washing with water serves to remove them, so that the resulting film when stained shows no polar bodies. The films should be gently covered with the appropriate stains, which are removed after thirty seconds with filter paper without washing.

The growth on medium No. 2 is not a luxuriant one; after twenty hours it is washed off in two per cent saline solution. When polar-body producing strains are cultured upon animal nucleic acid media containing histone and protamine, under the discrete gonococcal colonies a white precipitate can be observed, and this has been found to be made up of the gonococcus meta-protein and primary albumoses, either combined with the free nucleic acid or with the histone or protamine; which compound is formed varies with the pH of the medium. For example, on the acid side of pH 7·2 the metaprotein and primary albumose nucleates are precipitated, whereas, on the alkaline side, the compounds of the metaprotein and primary albumoses are precipitated combined with the histone or protamine. This reaction within the medium seems to detoxicate the culture by precipitating the precursors of endotoxin, e.g., deutero-albumose in the metaprotein and primary albumose stage. This detoxication takes place gradually during culture as autolysis of the gonococco-phospho protein progresses through the various intermediate products, and such products diffusing into the medium are gradually precipitated in the manner indicated above.

No. 3.—This is a special medium for the preparation of gonococcal endotoxin or the toxic and provocative fraction of gonococcal metabolism. Details are given below.

The successful preparation of the gonococcus endotoxin depends upon completely changing, by means of the organisms' own enzymes, at least ninety to ninety-five per cent gonococcus phospho-protein through the stages of alkali metaprotein, primary albumoses into deutero-albumoses, and excluding the non-specific toxic irritants from the medium which, when present, cause non-specific provocation in the case of the healthy urethral mucosa and so prevent the use of endotoxin as a test of cure. Dosage is one cubic centimetre, containing the product of 250 millions as an instillation into the urethra.

This process is exactly the reverse of that employed for exotoxin or nucleo-protein stimulation, e.g., all precipitants of the endotoxin precursors are excluded from the medium, and the conditions arranged so that complete autolysis of the organism takes place.

Media Employed..

No. 1. *Standard Medium for Gonococcus Isolation* (*Woolwich*).—Is prepared in two parts, A and B :—

A. Alkaline autolysate of fresh ox heart.

B. Six per cent peptone-agar.

A. The ox heart must be fresh, all pans, vessels, mincer, etc., used for conducting the autolysis should be sterilized (autoclave). The heart is ruthlessly freed from fat, connective tissue, fibrous tissue, etc.

It is cut into two-centimetre cubes, minced, and sterile distilled water added, one cubic centimetre for each gramme of muscle tissue. If the heart is fresh forty cubic centimetres N. NaOH per kilogramme are added. When autolysis has proceeded for twenty-four hours in the ice-chest and the subsequent manipulations are completed, the pH of the resulting extract will be pH 7·2. After twenty-four hours autolysis the fluid extract is separated from the muscle tissue and placed in flasks in 500 cubic centimetres bulk (not more or less). The red extract is placed in a Koch's steamer and steamed for fifteen minutes exactly. The coagulated muscle proteins are allowed to settle and the reddish brown fluid decanted into sterile flasks, again in 500 cubic centimetre bulk. No straining or filtration must be employed. The 500 cubic centimetre flasks of extract are heated for five minutes on three successive days. Thirty minutes are used therefore for the preparation of the extract, and, as the extract must not be heated longer than forty-five minutes, this allows fifteen minutes heating for the subsequent procedures in the preparation of the medium. Any departure from the bulk of extract dealt with or the time of heating renders the extract unfit for gonococcus culture, and the final pH of the extract will not be 7·2, as required.

B. *Six per cent Peptone-agar.*—This is prepared separately and contains :—

(1) Peptone (Witte)	6 per cent
(2) Agar (must be fibre)	6 ,,
(3) Sodium chloride	1 ,,
(4) Disodium monohydrogen phosphate ..	1 ,,
(5) Sterile distilled water, *q.s.*	

The above, in flasks, is placed in the Koch's steamer long enough to melt the agar. When melted, it is steamed on the following day for half an hour. Both A and B being ready for use, B is placed in the steamer and melted; when melted the heart extract is heated in the steamer for five minutes and equal parts of A and B are mixed without further treatment. When the medium is cold its pH is 7·2. The medium is tubed, and, dealing with 400 cubic centimetre bulks of medium, the heating required prior to the addition of serum is on an average ten minutes, so that the extract is subjected to the heat at 100° C. for no longer than forty-five minutes.

After tubing, the tubes are placed in a water bath at 45° C. and 2·5 per cent of human serum added and the medium sloped.

Suitable tubes for the medium are one-inch by eight-inch. No hydrogen ion concentration measurements are required, because, if prepared as above indicated, the medium at room temperature will be pH 7·2. If no Na_2HPO_4 is added the pH of the finished medium will be 7·1.

The blood serum used is obtained in the usual way from gonococcus patients during the first two or three days after admission to hospital. That obtained from patients at a later date, or from chronic cases of gonorrhœa, should not be used, as it is definitely inhibitory to gonococcus culture primary isolation, though not so after the first subculture. Ten cubic centimetres of medium in the culture tubes of thirty cubic centimetres capacity are kept at 45° C., and with a graduated pipette 0·25 cubic centimetre serum is added to each tube, which is rotated in a wide circle (not shaken) and sloped. It has been found that A and B in 200 cubic centimetres bulk is satisfactory for the successful carrying out of the above technique, and no pH estimations are required at any stage of the procedure.

No. 2. A Medium for Culture of Gonococcus and Preparation of Gonococcus Exotoxin (polar body production).—Medium consists of :—

A.	Peptone (Witte)	6 per cent
	Salt	1 ,,
	Disodium hydrogen phosphate	1 ,,
	Agar (shred)	6 ,,
	Glucose (make 200 c.c. with distilled water) ..	0·2 ,,
B.	Thymus gland (desiccated), (best from Messrs. Willows, Francis Butler, Thompson, Ltd.)..	1 ,,
	Alpha thymo-nucleic acid (British Drug Houses)	0·2 ,,
	Or nucleinic acid (yeast) (Martindale) ..	0·2 ,,

Make 100 cubic centimetres with extract of ripe herring sperm. The ripe herring sperm is prepared by adding one cubic centimetre of distilled water to each gramme of ripe herring sperm, the roe being thoroughly broken up. It is steamed with shaking for half an hour and the thick, milky fluid decanted from the coarse particles. The milky extract is sterilized by heating for twenty minutes for three successive days when it is ready for use.

C.	Alkaline ox heart autolysate	100 c.c.

Heat of steamer at 100° C. used throughout. No filtration done at any stage.

Preparation.—A day before making medium prepare A by melting agar with other ingredients. Heat long enough to melt the agar to a uniform gel. Add the glucose when the agar is melted so as to avoid prolonged heating of the carbohydrate. Prepare B. Bring to pH 7·2 and sterilize.

On the day of preparing medium, heat A to melt agar until a uniform viscous fluid; heat B half an hour, heat C five minutes. Add B and C to A, making 400 cubic centimetres of base medium.

Tube in ten cubic centimetres bulk in tube with twenty cubic centimetres gas space. Add 2·5 to 5·0 per cent serum (human). 0·1 per cent

glucose is present in the medium in order to balance by the H ions resulting from its fermentation the OH ions shed into the medium as a result of ammonia production during culture in the first twenty hours, and so maintain the pH at 7·2 for this period. Constancy of pH can also be maintained, under the above conditions, without the presence of glucose, by simply capping and hermetically sealing the tube. In this case the CO_2 resulting from gonococcus metabolism almost exactly balances, with its increasing percentage of CO_2 and resulting addition of H ions to the medium, the OH ions resulting from ammonia production.

Other methods of obtaining constancy of pH which is necessary to antigen production and detoxication can be used, e.g., the gas given off by bicarbonate solutions of varying normality can be used to buffer the gas space against the CO_2 from gonococcus metabolism, and by means of the constancy of CO_2 percentage so attained the OH ions resulting from culture and raising the pH of the medium can be accurately balanced. Bicarbonate of the required normality must be also added to the medium in this method of obtaining constant pH, or a very large jar such as Bulloch's jar, gas tight, can be used and filled with the required percentage of CO_2. Here the CO_2 due to culture added to the large gas space is too small to make an appreciable difference in the pH of the medium.

Polar body production is optimum between pH 7·2 and 7·4 above, and below it is not developed, so necessitating one or other of the above balancing methods or alternatively the following : We have also preserved the medium pH within the limits prescribed by using adequate buffering, e.g., N/10 phosphate system which with the buffers of the peptone and meat extract is untouched by the OH ions shed into the medium for six to seven days.

We prepare it by using, instead of distilled water in A, a solution of N/5 phosphoric acid 100 cubic centimetres ; this is brought to a pH of 7·2 by N/5 NaOH (100 cubic centimetres approximately) and bulk of fluid made 200 cubic centimetres ; the other ingredients of A are then added and the medium prepared as above detailed.

To ascertain pH changes during culture, up to not more than 0·002 per cent, phenol red is sufficient and does not inhibit growth or polar body formation.

No. 3. Standard Medium for the Preparation of Gonococcus Endotoxin.—This consists of three parts, A, B and C.

A.	Alkaline autolysate of ox heart	100 c.c.
B.	Peptone (Fairchild)	4 per cent
	Agar (fibre)	6 „
	Salt	1 „
	Sodium bicarbonate N/33	200 c.c.
C.	Mucin, 0·5 per cent	100 „

B is prepared the day before the medium is tubed by melting the first three ingredients and adding the sodium bicarbonate when the agar is

melted. A, B and C are mixed and tubed and 2·5 per cent fresh human serum added before sloping. The pH of the finished medium is 8·4 pH.

When the culture is placed in a large boiling tube containing N/10 sodium bicarbonate solution, the percentage of CO_2 in the gas phase is kept constant and the pH of the medium reduced to 7·2, at which it is maintained during the ten days culture is allowed to proceed. The sodium bicarbonate solution yields 3·9 per cent of CO_2 to the gas phase and the CO_2 resulting from gonococcus metabolism beyond this percentage passes back to the N/10 bicarbonate solution, so maintaining constancy of CO_2 percentage. Alternatively the cultures, according to their bicarbonate content, can be placed in large sealed jars containing the appropriate percentage of CO_2 in order to reduce the pH to 7·2 and maintain it constant at this point. During the first year an acid autolysate was used for endotoxin preparation, but lately it has been found that the alkaline autolysate gives even better toxin production and avoids the necessity of several types of ox-heart extract. The above provides a hypotonic, low-buffered medium upon which the gonococcus is grown and autolysed for ten days. After ten days' culture the growth is suspended in distilled water and frozen and thawed on an average six to seven times until the supernatant fluid is of a uniform blue (like watered milk) and the deposit of the gonococcus culture bodies has a violet tinge.

The standardization is carried out in the usual way and the endotoxin put up in a strength of: Toxin from 250 million gonococci per cubic centimetre in a menstrum of colloidal silver (1 in 32,000), the latter being the only available bactericidal agent which does not interfere with the properties of the toxin.

The endotoxin must be kept in the dark or in an ice-chest. Light causes precipitation of the silver colloid with the toxin adsorbed on the particles of silver. The beginning of this change is noted by the yellow colour of the preparation becoming green and opalescent instead of a clear orange yellow. Subsequently a black precipitate settles out leaving a clear watery supernatant fluid. In this state the toxin is inert and useless.

NOTES ON MEDICAL SERVICES IN THE FIELD.

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The subject matter of these articles was originally compiled as notes for the instruction of a class of officers working for examination for promotion to Lieutenant-Colonel. No originality is claimed for them, as they were culled from various sources. Before the publication of the "Medical History of the War," the Journal of the Royal Army Medical Corps, together with articles from other journals and manuals and a certain amount of actual experience, supplied most of the material. This was greatly added to as the volumes of the "Medical History" appeared. It was intended to publish the results at an earlier date for the benefit of other toilers in the same field, but it was deemed advisable to await the publication of the long-expected new edition of the "R.A.M.C. Training." When this made its appearance it was found to contain much of the subject-matter in very concise form, with which it is therefore not necessary to deal fully in these notes, except so far as the upkeep of the narrative is concerned. There are, however, certain aspects with which the manual does not deal except in a general way, especially with regard to operations out of Europe, and reference to some of these, it is hoped, will be of interest and help to those whose fortune or misfortune it is to have to serve in foreign lands.

PART I.

The Regimental Aid Post.

It is better to consider the commencement of the activities of the medical services at the front line rather than work up from the base to the front. The regimental establishment of the infantry battalion to-day consists of the medical officer, his batman, medical orderly, and the driver of the Maltese cart. To these, when in action, are added the band-sergeant and twenty-one bandsmen trained as stretcher-bearers, that is, five stretcher squads of four men each supplied with stretchers by the unit. In addition to these, but not directly under the medical officer, are the sanitary personnel, two per company, and in the headquarters wing the pioneer serjeant and his eight men supply both sanitary and water duty personnel. The latter are no longer supplied by the R.A.M.C., so the necessity for training regimental men for these duties during peace time is obvious. The stretcher-bearers may be increased by the use of prisoners of war or by men supplied by the brigade or divisional commanders from the battalion or other troops in reserve.

It is necessary at all times for the medical officer to be in close touch

with Battalion Headquarters, and in static warfare the regimental aid post is sited in some suitable spot in its vicinity, so that he may keep himself informed of the happenings at the different portions of the battalion front. The regimental stretcher-bearers are distributed amongst the companies, and it is frequently found that each stretcher squad of four divides itself into two and forms two squads, utilizing additional stretchers obtained through the field ambulance of the brigade or direct from Ordnance.

When troops are advancing, casualties are attended to and collected into groups by these bearers, who should utilize shell holes, empty trenches, sunken roads, etc., for shelter; messages should be sent back if possible to Battalion Headquarters or to the regimental aid post, indicating the position of these groups, or flags should be fixed to show their locality. From here the casualties should be removed by the reserve additional bearers to the regimental aid post, near which the latter remain till required under the orders of the medical officer. The best time for collecting casualties is during the lull between attaining an objective and the enemy's counter attack.

The men should be impressed with the necessity of taking advantage of cover, even if by so doing the journey is made a little longer. The ground may be broken up by deep nullahs, and where possible these should be utilized, but it is very tempting to go over the top and take a short cut; and many casualties among stretcher-bearers occur in this way. In trenches the use of the trench stretcher is necessary, but ledges may be cut at the corners to enable the long stretcher to be lifted head high and the corner negotiated without exposing the casualties or bearers. Shelter and protection should always be arranged for waiting stretcher-bearers, both regimental and those attached from the field ambulance for communication purposes. The feeding of the latter will have to be arranged when the force is on the move.

As regards the construction of the R.A.P., in a rapid advance or a retreat nothing is usually possible beyond the utilization of existing buildings or natural shelters. Whenever possible shelter from rifle fire and shell splinters should be obtained. When the advance is sufficiently slow, or in position warfare, more efficient protection should be given, the O.C. unit being requested to carry out the work of construction. Protection from direct shell fire may be possible by excavating deep dug-outs, but two exits are advisable in case one becomes blocked. These entrances and exits must be made gas-proof by the requisite double blanket doors charged with a gas absorbent solution, and they must be of such a width and slope as to allow of loaded stretchers being brought in and out. Gas-proof construction work is preferably carried out with the help of the R.E. and gas officers.

Whatever form of protection is utilized, e.g., dug-out, sandbag shelter, cellar, cottage, etc., its capacity should be sufficient to accommodate twenty to thirty men. In dug-outs the walls may be ledged to allow lying cases to

be placed on them, or three-tier rabbit wire bunks may be made, thus saving space. Sufficient means of ventilation must be allowed for, though ventilators should be made gas-proof, and not brought into use during an actual gas attack, as gas is liable to be drawn in through the doorways with the air to replace that which has passed up the ventilators.

Clothing saturated with mustard gas should, if possible, be removed outside before entry and not taken into the R.A.P. If taken in it should be removed outside at once. At one time in the Great War a tray of bleaching powder was placed at the entrance of the room, for bearers and patients to tread in and so to nullify the effects of mustard gas on their boots; it was found that mud carried into the dug-out later gave up its mustard gas. A point to be remembered in connexion with gas casualties is the provision of gloves of oiled or gas-proof material for the use of bearers or orderlies who have to handle clothing sprinkled with mustard gas. Any gas-infected clothing removed should be soaked in soapy water, or placed in a gas-proof sack for removal to the A.D.S. for treatment, when this cannot be done at the R.A.P. As regards the equipment necessary, lack of transport usually forbids of more than the regulation amount being taken. But in position warfare, it is generally possible to arrange for additional articles when large numbers of casualties are expected. Amongst these may be numbered 10 to 50 additional stretchers, 20 trench stretchers (Rogers), additional directing flags for denoting groups of casualties, 100 blankets, 10 Thomas splints, shell dressings, ordinary dressings, transfusion apparatus, chloride of lime (oxygen administration apparatus, though desirable, may not be obtainable and in any case requires much transport), food and water heaters and fuel, e.g., Primus stoves, extra water containers, hot-water bottles, extra lights, e.g., hurricane or acetylene, and last but not least a number of empty sand-bags for packing dressings, etc., when it is necessary to make speedy advance to another R.A.P. If gas casualties are expected, a few suits of pyjamas are advisable.

Communication with the Advanced Dressing Station must be established at the earliest possible moment. It is the duty of the A.D.S. to get into touch with the R.A.P., but the Regimental Medical Officer should try and establish touch from his end and get a message back. The Battalion Commander has generally been notified of the position of the A.D.S., but the Officer i/c A.D.S. does not know that of the R.A.P.'s, especially in mobile warfare, and has to find them out. The method generally adopted is for the Field Ambulance Commander to attach two or four men of a stretcher squad to the M.O. of a unit preparatory to an attack for the purpose of sending back messages as soon as the R.A.P. is established, and of ascertaining the line of evacuation to the A.D.S. Other methods are the utilization of walking wounded for this purpose, and the sending of messages by unit telephone through brigade or divisional headquarters signals. In this connexion it should be noted that information of every change in location of the R.A.P. should be sent back to the A.D.S. or to the Bearer

Officer immediately. When possible, too, touch should be kept with the M.O.'s of units on either flank, as it may be possible to combine or site R.A.P.'s side by side, or to arrange mutual collecting areas with Battalion Headquarters, as, for example, when advancing along both sides of a river.

Replenishment of medical supplies is obtained by indent on the field ambulance serving in the brigade. Under normal conditions indents should be sent in at definite times under arrangements with the O.C. Field Ambulance, for whilst a certain reserve is always maintained at the A.D.S. for emergencies, larger supplies have to be obtained by him from the Advanced Depot Medical Stores, which should, but may not be, within easy reach of the Main Dressing Station. It should be remembered that the field ambulance has limited transport and cannot carry large stocks of reserve supplies.

Medical comforts should be obtained by direct indent on the R.A.S.C. or Supply Officer through the Battalion Quartermaster, though in some instances orders are issued for the supply of these by field ambulances. This last-named unit is frequently used as a channel for getting requirements sent up by M.O.'s i/c units, as supplies to field ambulances can often be sent up by returning medical transport and their delivery expedited. As in the case of Advanced and Main Dressing Stations, there are times when the supply of hot drinks to casualties is essential, and these should always be available when the unit is acting independently, or on an extreme flank, or in an isolated position, or when the advance has been too rapid for the field ambulance bearers to get up, or when evacuation is delayed for any reason or cannot be carried out, as for example at night in outpost positions.

Ammunition should be removed from men before evacuation. It is likely to be required in the front line, and it should be collected from the R.A.P. under unit arrangement. As regards arms and equipment, these formerly accompanied the man as far back as the C.C.S., where those of men evacuated to the L. of C. were collected and handed over to the Advanced Ordnance Depot. Under present arrangements the collection is made at the A.D.S. or some spot in advance, whence they are removed under divisional arrangement. In small forces they are taken over by the man's unit, which arranges their disposal.

The question is frequently asked to what extent should medical attendance on the wounded be carried out in the R.A.P.? This may be answered by saying that during active operations only those measures should be adopted that will allow the casualty to be transported with safety, comfort, and rapidity to the nearest medical unit which will be able to deal properly with his condition. Chief amongst these requirements are the stopping of hæmorrhage by tourniquets, ligature (if necessary) and pressure bandaging, the protection of wounds from further contamination by the application of dressings, the immobilization of fractures for the journey, the use of suitable splinting, the combating of

shock by warm drinks, stimulants, hot-water bottles, and occasionally by transfusion, the relief of pain by the judicious use of morphia, and in gassed cases the removal of clothing saturated with mustard gas, the washing of liquid from the skin and the use of oxygen, if available, for acute cases of irritant or suffocating gas poisoning.

As the aim is to get the casualties back to the C.C.S. as rapidly as possible, no time should be wasted on measures of doubtful immediate value, seeing that they will be repeated in the space of a very few hours when fuller and more beneficial attendance can be given to the wounds. If retention at the R.A.P. must necessarily occur, then more elaborate wound toilet must be performed. As regards the administration of anti-tetanic serum, this is, under present teaching, deferred until the arrival at the M.D.S., assuming that a rapid evacuation is possible, but always with the proviso that should delay in transportation from the R.A.P. be likely, it must be given there.

Field medical cards, A.F.W. 3118, should, if possible, be made out at the R.A.P., and entries of importance must be entered on them, e.g., the application of a tourniquet, administration of morphia, strychnine or anti-tetanic serum, and in the case of gas casualties any unusual symptoms. The adoption by arrangement of the more rapid method of indicating certain of these measures, e.g., a "T" on the forehead in indelible ink for anti-tetanic serum, or an "M" for morphia, should always be repeated by an entry on the card. The former may be washed off or the latter may be lost. For his own information and that of the Battalion Commander the M.O. should, as far as possible, record the names, nature of wounds and condition of all casualties sent back to the A.D.S. Formerly the counterfoil of the tally-book served this purpose, but this book is now obsolete, having been replaced by the field medical card.

Triage.—Before passing on to the description of the next link in the chain of the Medical Services, it is desirable to speak of a term which is used by French writers, and on the intelligent understanding and interpretation of which depends to a large extent the proper treatment and distribution of casualties. The word "triage" is referred to, and it is applied to a section of the duties which have to be performed to a smaller or greater extent by every medical post or unit from the front line to the last convalescent depot. By it is meant the selection of the casualties and their division into different categories according to the manner in which they are to be dealt with for treatment and evacuation. These three categories are: (*a*) Curable in a short time, (*b*) non-evacuable, and (*c*) evacuable. The nearer to the fighting line the post or unit making the triage, the less complete is it possible to make it. But it is essential that it should be done at each stage through which the casualties pass, to prevent the rearward movement being greater than necessary and to divide it up into its proper channels.

In its "lay" form it really begins in the fighting line itself; the platoon

N.C.O.'s and company officers are frequently its exponents, retaining the slightly afflicted by encouragement or by the application of first field dressings, and sending back the wounded, though willing, fighter to get more skilled and necessary treatment than they have been able to give. At the R.A.P. the M.O. with his medical knowledge divides them up into (*a*) those for retention with the unit, and (*b*) those for evacuation. The former, (*a*), can be subdivided into such groups as malingerers, fugitives, slightly wounded or sick, temporarily unevacuable, the dying and the dead; the latter, (*b*), must be divided up for purposes of treatment into such divisions as (1) wounded, (2) sick, (3) gassed, and (4) shocked, the wounded being further selected according to the nature and urgency of their requirements, e.g., hæmostasis, fracture immobilization, simple dressings, etc., and for purposes of transportation by field ambulance bearers they must be classified into (1) lying, (2) sitting (pick-a-back or hand carriage), and (3) walking. The proper triage of the gassed or possibly gassed cases is of especial importance.

At each new medical post or unit that they reach they are submitted to a fresh triage and dealt with according to the rôle ascribed to that unit. An experienced officer carrying out the triage will perform the work more rapidly, prevent congestion by determining those in which operation can safely be delayed, save lives by submitting others for immediate operation, and prevent loss to the fighting line by retaining those who are likely to recover in a short time. The characters of the triage are directly dependent on the state of activity of operations; for during a period of inactivity retention will assume preponderance over evacuation, at any rate in the bedded units, whereas in times of stress the latter must be very much in the ascendant.

The account of the field ambulance which follows deals with a purely British unit as manned and equipped in England for service in a civilized country under normal conditions, and is based on the experience gained in the recent Great War in Europe. But it is to be remembered that for service in other countries, where conditions differ from those obtaining in Europe, considerable modifications in formation, personnel, equipment and transport may be and are necessary, as, for example, in the present field ambulance in India, which is adapted to meet the requirements of a combined British and Indian force serving in hot climates and in less or uncivilized countries. But the principles on which the working of the unit is based are much the same for all modifications of it, though the elaboration may be too great in some cases; but even with a fully turned-out British unit it is more often than not impossible to carry into effect the full quota of the rules of procedure. The present tendency is to base the formation of all modifications of the British unit on that unit and to conform to it as much as possible, and so standardize personnel, equipment and methods of working. This, of course, is distinctly advantageous for purposes of training, as personnel may be called upon to serve in more

than one variety of the same unit; and again, units of different varieties may be called upon to work side by side in the same or combined formation. It therefore follows that a knowledge of the British unit is applicable to modified units, and is further of importance as being that on which examinations for promotion are based. In a later communication, if opportunity permits, it is proposed to give some account of an Indian field ambulance, but as at the present time there is the possibility of considerable modification of the existing one, the description is better deferred.

The Field Ambulance.

This is the first medical unit to which the wounded man is taken after he has received regimental treatment. It is a unit of many parts, being adaptable to many uses and supplying offshoots which are applied to different purposes as occasion demands. It is essentially mobile, though some of its employments may render it more or less fixed temporarily; yet at very short notice it is usually able to assume its proper function of collection of casualties and their speedy transportation from the immediate front area towards the rear, whilst giving them any necessary treatment and shelter until they can be taken over by a motor ambulance convoy, and removed to a casualty clearing station. But the unit is not altogether by any means a transportation unit, as it is capable of retaining its sick and wounded for long periods, and acting as a hospital if occasion demands, which it frequently does; in ordinary times it acts as the front line hospital for cases which are likely to recover and to be returned to their units within a few days. Abroad, when an independent column moves out and lines of communication are only opened by the periodical despatch of armed convoys, medical units must be capable of holding their casualties for seven days.

The variety of the functions of this unit may be seen by a study of the following list of rôles which it has from time to time been called upon to undertake:—

(1) Field ambulance proper with the formation of: (*a*) main dressing station; (*b*) advanced dressing station; (*c*) bearer relay posts; (*d*) divisional collecting post; (*e*) advanced reserve bearer post; (*f*) rear reserve bearer post; (*g*) sick loading post (*h*) divisional motor ambulance convoy.
(2) Walking wounded collecting post
(3) Sick collecting post.
(4) Gas treatment centre.
(5) Resuscitation centre.
(6) Rechauffement centre.
(7) Massage posts.
(8) Local sick rooms in back areas.
(9) Rest station for Division or Corps.
(10) Officers' hospital and rest station.

(11) Special hospital, e.g., for scabies cases, infectious diseases, etc.
(12) Mobile medical detachment.
(13) Reception station for casualty clearing station and surgical team provider.
(14) Medical staging posts.
(15) Laundry.
(16) Bathing establishment.
(17) Disinfesting and disinfecting unit.
(18) Water posts.
(19) Sanitary posts.

In fact, there is scarcely any duty of a medical (and sometimes non-medical) nature that it may not be called upon to perform at some time or another. It is its extreme adaptability, rendered possible by its composition as regards both personnel and equipment, which enables it to become a Jack-of-all-trades-medical, and to carry out any of those multifarious duties which the situation may demand of it. The variety of work makes it an extremely interesting unit to be serving with, and it sees a great deal of what is going on in its own area at the front, and it rarely stagnates; life with it is an extremely busy one, and demands activity of both body and mind.

The full details of its composition are to be found in War Establishments and War Equipment and Medical Mobilization Equipment Tables, in default of a Field Service Manual Medical of modern publication; but a brief summarized description may not be out of place. The unit consists of a Headquarters and two companies, each complete in itself but with different functions, equipment and personnel being furnished accordingly; though it is possible for one to assume the duties of the other with modification.

Its authorized accommodation is "for 150 patients," though War Establishments carefully adds further, "but not limited to this number." A limit must be made whereon the complement of personnel and equipment must be based. But in actual practice it has often to be exceeded considerably. In France, on many occasions a field ambulance was called on to deal with several hundreds of casualties daily for some few days.

The Headquarters acts as the hospital proper, store depot and unit, motor ambulance convoy, and in it the Officer Commanding has his office. It forms the Main Dressing Station, and on account of its accumulated additional stores and the nature of its work is less speedily got on the move than are its two companies. Its officer personnel consists of 3 M.O.'s (including the O.C.), a Dental Officer and Quartermaster with 1 to 4 attached Chaplains; its other ranks R.A.M.C. number 51, made up of all the usual classes required for field hospital work, and including now a barber and a carpenter but not a shoemaker. Nursing Orderlies and N.C.O.'s number 16, but there are no stretcher-bearers as such, their duties being performed by any of the personnel, and by wagon orderlies, of which there are 12, when these are not employed on the ambulances. In

addition, transport details of the R.A.S.C., H.T. and M.T. increase the numbers by 33.

The authorized medical equipment is much the same as in the companies, though reserves are greater. It consists of the usual field medical equipment with the addition, amongst other articles, of extra Thomas leg and arm splints and shell dressings, oxygen and ether administration apparatus, field dental outfit, etc. Tents are few, viz., eight circular double-fly and one operating tent, it being intended that buildings shall ordinarily be utilized. The companies have no tents, except when tents are required for accommodation of sick, and are issued under special instructions; in this case headquarters get an additional twelve tents and each company six with the necessary transport. Other equipment necessary for the running of dressing stations is supplied more liberally (and in some cases only) to Headquarters; amongst it are now to be found Soyer stoves, blacksmiths', carpenters', and masons' tools, acetylene lamps, a Lelean sack disinfector and one travelling kitchen. Motor ambulances consisting of 2 heavy and 6 light cars, 6 collapsible wheeled stretchers and 1 cycle, are collected in Headquarters, but the 3 motor cycles are equally divided, as heretofore. Four horsed ambulances are divided between the two companies only. The other Headquarters transport consists of 1 heavy motor lorry, 1 limbered wagon, 1 officers' mess cart, 1 Maltese cart, 1 water tank cart and 1 travelling kitchen; in the new R.A.M.C. Manual 3 light lorries are shown instead of 1 heavy lorry. As regards stretchers, those supplied to each company, viz., 12 each, have no slings or cushions, being intended for shoulder carriage by the stretcher-bearers, whereas 20 of the 24 supplied to Headquarters have both. Of these 6 are required to complete the wheeled stretcher carriages, the remainder being utilized for other purposes, viz., extra dressing or operating tables, cots for serious cases, intra-unit carriage of patients, and replacements for ambulances when off-loading lying casualties. Motor ambulances have their own stretchers additional to the above, and so presumably have the four horsed ambulance wagons, Mark VI, though such are not shown in the tables.

The normal supply of blankets is sufficient to give one per authorized casualty in Headquarters, viz., 150, with an additional 50 with each company for use at Advanced Dressing Stations and in horsed ambulances, etc. Motor ambulances have their own additional ones, 8 per heavy and 4 per light car.

The rôle of each of the two companies is to form an advanced dressing station, and to collect and transport casualties from the regimental aid posts or from other collecting posts where they may have gathered or to which they may have been brought when the R.A.P.'s have moved on. Very frequently one company assists the Headquarters, or the other company, but it may act independently; or it may be split up into bearers or dressing station sections and be allotted tasks accordingly. The personnel of each company, including attached, numbers 66, there being

53 R.A.M.C. and 13 R.A.S.C. Of the former 3 are officers, 38 are stretcher-bearers, 6 are nursing orderlies, and the remainder N.C.O.'s and men trained in the special duties necessary for making a small hospital unit complete in itself. The stretcher-carrying capacity per company is 9 squads of 4 bearers each, with 2 N.C.O.'s The equipment has been referred to above. It is less in amount than that of Headquarters, and therefore more rapidly handled, in order to meet with requirements of mobility and speed. (It may be mentioned that the Thomas leg splints, when taken out by the bearers, are carried "threaded" on to the closed stretchers.) With the exception of a motor cycle the transport, both ambulance and baggage, is all horsed. It consists of 2 ambulance wagons, Mark VI, 3 limbered wagons and 1 tank water cart. It is thus possible for it to operate on tracks which are not feasible for motor transport, such as field roads, especially in wet weather, and across country, river fords, and roads torn up by shells and mines.

The total effective strength of the medical unit on authorized scale consists therefore of 11 officers and 196 other ranks; its transport consists of 15 riding and 46 draught animals, 3 motor cycles, 1 cycle, 8 motor ambulances, 4 horsed ambulances, 1 Maltese cart, 1 officers' mess cart, 3 water carts, 1 travelling kitchen, 1 3-ton lorry, and 7 limbered wagons, together with 1 light lorry for supplies attached to the divisional train.

Dressing Stations.

So much valuable information as regards the siting, construction and function of these is now given in the R.A.M.C. Training Manual that it is unnecessary to deal with more than a few points of importance. As regards the M.D.S., the actual siting is made by Headquarters of the formation under which the unit is serving, on the recommendations of the A.D.M.S., whenever it is possible to select it beforehand. When available, schools usually make the most suitable buildings, but buildings, tents, or improvised shelters are made use of. The division into sections or rooms for a definite purpose should always be made as far as the accommodation permits. Briefly these are: (*a*) A large reception room, further subdivided into (i) recording, (ii) triage, (iii) waiting, (iv) rechauffement sections; (*b*) dressing and operating room; (*c*) evacuation room for (i) lying, and (ii) sitting cases; (*d*) retention room for those lying cases that cannot be moved at once; (*e*) separate accommodation for gassed cases, with arrangements for lavage and for dealing with impregnated clothing; (*f*) quartermaster and supply store; (*g*) pack stores for arms, equipment, boots, etc.; (*h*) cookhouse; (*i*) latrines; (*j*) mortuary; (*k*) water supply and bathing facilities; (*l*) quarters or lines for personnel; (*m*) ditto for transport, near or at a distance, depending on facilities of approach and the exposure to enemy fire; and (*n*) gas- and shell- proof accommodation to which to remove waiting casualties in case of attack from the air or heavy shelling.

The Main Dressing Station must be near the road leading from the

A.D.S., with good approach for motor ambulances, and if possible have a separate exit for them with good connection with the rearward roads, so as to avoid obstruction by cars of the M.A.C. when clearing casualties to the C.C.S. If the approach is bad some arrangement must be made to stop cars outside at some suitable spot where blockage will not be caused, and to direct the traffic in and out. If there is sufficient space in front of it to allow parking and turning of the cars, some overhead camouflaging is advisable to prevent detection by enemy planes; and this is especially necessary at the actual entrance into the reception room, where much movement takes place and where lights are ordinarily visible at night. The distance from the A.D.S. is usually given as two to five miles, though, if communications are good, this may sometimes be exceeded. The site will usually depend on the availability of suitable buildings, to meet requirements, and their accessibility. It should be out of range of field guns, but it will rarely be possible to give freedom from fire of heavy long-range artillery if brought up by the enemy. For protection from the air, too, it is better situated off the main road, away from military store dumps, railway stations, lorry parks, etc., where movements are continually taking place, and which are likely to attract the attention of the enemy and be bombed. Its locality must be indicated where necessary by directing flags and at night by protected lights. It is advisable, too, to have the "In" and "Out" gates so marked as to be distinguishable at night.

There are two procedures for the proper carrying out of which it is exceedingly important that a cut-and-dried and almost fool-proof system should be adopted in each case. These are: (1) The recording of all admissions and completion of field medical cards; and (2) the securing, and distinguishing, and reissue of arms and equipment. When casualties are being rapidly brought in car loads in speedy succession, it is often not possible to get the particulars of each man as he passes the door. His field medical card may or may not have been completed at the R.A.P. or A.D.S., through which he may not perhaps have passed. A system such as the following will reduce errors to a minimum: Tally-books of tickets containing foil and counterfoil, each bearing the same number, are prepared for each day's casualties, the pages being numbered consecutively, and the series carried on in the next book, or, which is more economical, a letter indicating the book number, e.g., A1, A2, etc., B1, B2, etc., is marked on both foil and counterfoil. These books can be prepared from strips of foolscap secured together in books of twenty or fifty (or other number), and bent in half to indicate foil and counterfoil. As each man passes the doorway, a foil is torn out and rapidly and securely pinned to the clothing on the man's chest; if time allows the man's name is written on the counterfoil. As soon as possible the man's full particulars are taken on the counterfoil and in a rough A and D book, each entry bearing the counterfoil number. If the man has a field medical card and envelope already attached, this should be left on him for the information of the surgeon and his

remarks, but any omission of particulars should be completed. *As soon as the particulars have been entered in the A and D book, this fact should be indicated on the counterfoil by one cross mark.* Should a casualty pass into the dressing room without this mark on the ticket, attention is immediately drawn to the fact that his admission has not been recorded, and steps are taken to have this done. The ticket remains on the man until he is evacuated, when it is taken off him and filed as he is loaded into the ambulance of the M.A.C., the other limb of the "X" being at the same time completed to denote evacuation. Field medical cards and envelopes are in the meantime being prepared or completed and attached before the removal of the ticket. An official foil and counterfoil, W 3240, are now issued for the above, the foils being sent to the O.'sC. the men's units to give information as to their disposal.

This system also enables a speedy check to be made on the numbers admitted or evacuated. Books of different-coloured paper, or marked differently, can be used for distinguishing the admissions of consecutive days, or periods of a day. And further, this system can be worked in with the registration of arms and equipment, which frequently arrive in the ambulance car all mixed up and have to be sorted out in the reception room and each allotted to its owner. A series of blank tallies, each with stout twine attached, is made ready, and the number on the man's registered foil is written on the tallies which are now fastened on the man's arms and equipment; these are secured together in one bundle as far as possible, sandbags for loose articles being supplied. If there is time a check is made and registered in a pack store book. The man's haversack, containing his few personal belongings and with tally attached, is usually retained by and accompanies him. On evacuation the haversack tally is presented at the pack store and his own arms, equipment, etc., are handed out in return, cleaned if possible. In times of inactivity, in order to ensure a man retaining his own arms and equipment, these remain with him until he reaches the C.C.S.; if likely to recover in a few days and not evacuated on to the L. of C., the articles are still shown on the pack store records of the C.C.S. or rest station to which he may be transferred, and so he rejoins his unit fully equipped; but in times of stress, when practically all have to be evacuated, and at any time when it is certain that he will be evacuated out of his army or possibly corps area, instructions are issued as to the points at which arms and equipment are taken from men and for the disposal of the arms; such points may be at the A.D.S. or M.D.S., and arrangements are made divisionally for their collection and disposal. Ordinarily arms and equipment collected by medical units are handed into the nearest Advanced Ordnance Depot, from whence they are reissued. Ammunition is retained as far forward as possible for return direct to units through the R.A.P.'s, or for collection and disposal by the A.P.M. under divisional arrangements.

The checking, recording, and securing of the kit of officer casualties at

the very first opportunity by the first responsible party taking it over is of vital importance to the O.C. unit, in order to safeguard the kit whilst in his unit and to protect him from charges of loss of articles during the period the officer is under his charge. All such records (including the officer's signature, if possible) should be safely preserved, receipts being obtained from the unit to which they are handed over by an accompanying orderly. Charges of this nature give rise to a considerable amount of ill-feeling between units and individuals, whether there be cause for them or not; and unless it is possible to preserve records of the event, it is practically impossible to refute the charges, as they usually come after some time has elapsed and memory of a single incident has been lost in the multitude of others that have since occurred.

In arranging accommodation, provision should be made for 100 severely wounded in addition to the walking and sitting wounded, and separate accommodation and arrangements for gassed cases, including 30 severely gassed. If trestles or stretchers are available to make beds for these severe cases, so much the better. When, as frequently happens, a two-storied building is being used, much labour and time are saved by sending the walking and sitting cases upstairs. Chair carriers are readily constructed and very necessary for the last-named class. Stretcher cases are much more easily and quickly manhandled on the ground floor.

Additional stores, in addition to those sent up to the A.D.S., should include small dumps of stretchers and blankets, not too big, as replacements are readily obtained from the C.C.S. These, together with an ample supply of petrol, should be suitably placed so as to be readily picked up by motor ambulances returning to the A.D.S. In times of stress a buffet, supplying hot drinks and food, should be arranged close to the petrol dump for the use of the drivers of the ambulance cars, who make journey after journey without being able to get their proper meals. Reserves of dressings, splints, hot-water bottles, boots, clothes, and pyjamas should be obtained beforehand, to enable the demands of A.D.S. and R.A.P.'s to be speedily met. Casualties in France were frequently brought in minus boots, coat and cap, and sometimes even without trousers. Trench boots were frequently worn, though they were not supposed to be brought from the front; a supply of repaired boots obtained from the Advanced Ordnance Depot enabled these to be removed and sent back to the A.D.S. for return to the unit whence they had come and on whose charge they were.

The motor ambulances are kept parked in some open space or adjoining or adjacent yard, if possible with cover from the air, and with quarters for the drivers; one or two cars are kept at the Advanced Dressing Station for a definite period of duty in position warfare, one is kept on duty for despatch at a moment's notice, and one in waiting at the M.D.S.

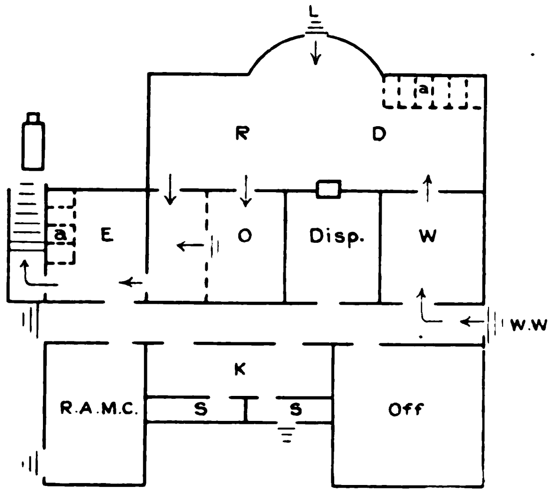
Communications are maintained with the A.D.M.S. by means of the cyclist and motor cyclist orderlies, and with the A.D.S. by means of the returning ambulance cars; but whenever possible an endeavour should be made to get field telephonic connexion.

ADVANCED DRESSING STATION.

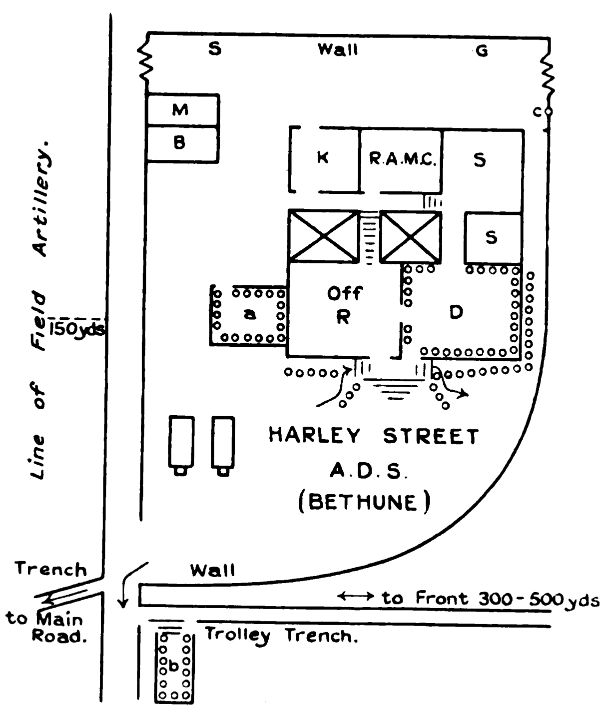
The exact site is usually left to the selection of the O.C. Field Ambulance or the Officer i/c the Company forming the A.D.S., though when possible the locality is fixed beforehand by Divisional Headquarters and published in orders for the information of front-line troops; if not so published the information must be sent forward to Brigade and Battalion Headquarters as soon as the A.D.S. is established and backward to the A.D.M.S. It should be situated as far forward as possible, allowing for reasonable protection from rifle fire and shell splinters, in houses, cellars, dug-outs, ravines and nullahs, remembering that any obvious natural protection is very likely to be searched out by artillery shell fire. For this reason cellars and dug-outs are necessary for periods of heavy bombardment and also for anti-gas protection. It is essential for the A.D.S. to have a good road approach or short access to a good road to enable the motor ambulances from the M.D.S. to come up and clear it. When it is not possible to site the A.D.S. on a motor road, then measures must be adopted to enable the casualties to be removed to a road, e.g., the construction of a short connecting link of road with the help of the R.E. for bridging, or the establishing of an intervening service of horsed ambulances, wheeled stretchers, hand carriage or light tram or trolley way to and from a car-loading post situated on the road. The aim in the forward situation is to shorten the journey as much as possible for the stretcher-bearers from the R.A.P., and to save time in evacuation by an early transfer to the more speedy motor transport. When it is possible to establish a loading post, whether for light cars or horsed ambulances, ahead of the A.D.S., which is often necessary in an advance, there is less necessity for the A.D.S. to be pushed to its extreme forward limits, whence, in the event of a speedy retirement, there is much less chance of being able to get away casualties that may have accumulated there.

Remembering the primary functions of the A.D.S. are to collect and transport casualties from the R.A.P. to the M.D.S., the aim should be to keep it mobile and not to make elaborate preparations which will render it slow in getting off the mark, except in position warfare. But, at the same time, a somewhat greater degree of comfort for casualties is expected than can be obtained in the R.A.P.; so though mobility must be ever kept foremost in mind, yet the *modus operandi* should be based on that applicable to a more firmly established unit, and the details of the recognized system of reception, dressing, and evacuation carried out as completely as is possible under the particular conditions prevailing. The organization should be on these lines, therefore, though the nature of the quarters or position occupied may necessitate considerable modification in the mode of application. It happens occasionally, especially in position warfare, that a building well adapted for the purpose is available, and of this there is no better example than the A.D.S. at Chateau Vermelles, during the battle of Loos in September, October, 1916, of which a diagram

A.D.S. AT CHATEAU VERMELLES.
(Loos).



L = Stretcher cases.
E = Evacuation.
W = Waiting-room.
Off = Officers.
WW = Walking cases.
O = Operating.
K = Kitchen.
R.A.M.C. = Staff.
R D = Reception and Dressing.
Disp = Dispensary.
S S = Stewards' stores.
a = Stretcher racks.



Basement.

R = Reception.
D = Dressing.
S = Stores (cellar).

Ground Floor.

Off = Officers.
K = Kitchen.
R.A.M.C. = Staff.

M = Mortuary.
B = Baths.
S = Sanitary.
ooo = Sandbags.

G = Graves.
a = Drivers' shelter.
b = Patients' dug-out.
c = Sniper's hole in wall.

is given in the "General History of the War," and which, for instructional purposes, is reproduced here. A less well adapted building was that of "Harley Street," on the Bethune-La Bassée Road, of which a self-explanatory rough sketch is given also.

Amongst the main measures should be the provision of accommodation for 100 casualties, at any rate in position warfare, with, if possible, separate accommodation for gassed cases or arrangements for their immediate transfer to an adjoining unit dealing with gassed cases alone. The reception room should be capacious to facilitate the making of the triage or classification, and the separation out of the urgent cases requiring immediate attention. The supply of hot drinks, warmth and cigarettes should be immediate and plenteous, and facilities for lying down should be arranged for, though care must be taken that men have their wounds attended to as early as possible. The evacuation system must be a rapid one to prevent congestion, and kept separate from the admission system. It is better to get cases through at once to the M.D.S., if their dressings applied at the R.A.P. appear satisfactory. But if men have to be retained for several hours, either on account of night or economy, insufficient transport, or for any other reason, then an efficient and thorough wound toilet is essential. It is to be remembered that a single lengthy dressing or operation prevents the early treatment of a number of slighter cases and leads to retention and congestion. The frequent replacement of dressings is in many cases unnecessary and wasteful both of time and dressings, as in all cases, except in the heaviest engagements, wounds are thoroughly exposed and dealt with at the C.C.S. The main surgical work will be in the direction of arresting hæmorrhage, application, securing and fixing splints, removal of tissues obviously only "hanging on," combating of shock, and in general in rendering the transport through the M.D.S. to the C.C.S. as little injurious and painful as possible. It has been found that severe casualties should remain as far as possible where they are operated upon, and that such cases will bear transportation before operation considerably better than after it. This with the need for early attendance is one of the main reasons for getting casualties to the C.C.S. as early as possible, and at any rate within six hours of being wounded. Anti-tetanic serum should be given if the casualty is likely to be retained before evacuation, or is not likely to be taken into the M.D.S.

An abundant supply of dressings is of course essential, as demands from the R.A.P.'s must be complied with at all costs; but judgment and good sense must be displayed in maintaining stocks of supplies so as not to have more than can be transported in case of a speedy move. A small reserve of rations is necessary in these days of long-drawn-out battles, for the stretcher-bearer personnel dependent on it, and also for casualties who come in ravenous through inability to obtain cooked meals in the front line. The proximity of a prolonged fixed engagement will be the signal for collection of other articles too, amongst which are blankets, 500 to 600; stretchers, 300 to 400; trench stretchers, 40 to 50; pyjama suits, 100;

serge clothing for the gassed; hot-water bottles, 60; Thomas and plain splints, oxygen cylinders, blood tranfusion apparatus, oil or other warming stoves, oil, calcium carbide and lamps, and sandbags; the last-named may be necessary for filling with earth for protection purposes, but are also useful for filling with dressings for sending to R.A.P.'s, and in case of having to send forward an advanced A.D.S. at short notice; in this event empty petrol tins for carrying forward water may be required. The extra blankets and stretchers are best distributed and located in small dumps at important relay posts, such as advanced and reserved bearer posts, so that in case of fire all will not be destroyed.

As regards clerical work, field medical cards should be made out and completed as far as time will allow, and a rough record of particulars of casualties passing through maintained together with their disposal. Men get lost from their units, and if early news of them can be given to unit commanders by the A.D.S. which is in touch with units, it is of great help to them. It is, further, a check on the numbers passing through the M.D.S., and helps to prevent a practice not unknown amongst light casualties of avoiding the A.D.S., whence they might be sent straight back to their unit, and getting picked up on the road by motor ambulances proceeding to the M.D.S.

Pack-store work is at a minimum, each casualty when possible retaining his own arms and equipment. If instructions have been issued for the withdrawal of these before evacuation, arrangements must be made for this, and a record of each man's belongings kept. In the case of officers no exception is made to the rule that an inventory must be taken at the earliest possible moment, and signed by the officer if capable of doing so. The kit, being private property, is secured and accompanies the officer on his rearward journey.

Periods for rest and food must be arranged for the personnel. Many of the bearers are out at the relay posts and have to be periodically relieved, or supplied with rations when the numbers are insufficient to supply reliefs. The Officer i/c Company should in periods of lull visit all his posts, though he has probably detailed an officer as bearer officer who will be supervising all details of their work. This officer acts too as liaison officer with the Headquarters of the brigade which the field ambulance is serving, but if with more than one brigade it may be necessary to appoint an officer for each brigade area. The principle of having brigade liaison officers is a good one, but the difficulty is usually a shortage of officers, necessitating the employment of the officer so detailed on other duties in addition. However, if the officer in charge of the bearers is energetic he can gain considerable valuable information by paying frequent visits to Brigade Headquarters, which will enable him to anticipate the course of events and to make his plans accordingly. In position warfare he may succeed in getting field telephonic communication set up between Divisional and Brigade Headquarters and the A.D.S.

(*To be continued.*)

A CRITICAL REVIEW OF THE PRESENT POSITION OF BACTERIAL AGGLUTINATION.

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(Continued from p. 116.)

III. Thermo-Stability and Thermo-Lability of Antigens.

In the previous sections of this paper the question of correlating the thermo-stability of certain antigen components with morphological, cultural, or other features of given micro-organisms was dealt with and the further attempted correlation of these with certain qualities of agglutination—floccular or granular—was also discussed.

In the following section further observations on the thermo-stability and thermo-lability of "antigens" will be made. At the outset it must be emphasized that there is more than one viewpoint involved in the discussion of this subject. The following point is therefore stressed: *That an "antigen" may be thermo-labile in the sense that after a certain exposure to heat it may be so modified that we cannot demonstrate its presence by* in vitro *tests. The same antigen may, however, be thermo-stable under the same experimental conditions in that it is able to stimulate production of antibodies on inoculation into animals.*

Futhermore, the degree of thermo-stability of a given reagent may not be constant, and therefore, the terms thermo-stable and thermo-labile, apart altogether from the question of the two points of view noted in the previous paragraph, are relative and arbitrary.

The following experiments exemplify this: Culture 49 *aertrycke* was isolated on August 24, 1924: it was used for immunizing an animal and the serum B/24 obtained was employed in carrying out the following tests:—

Ordinary twenty-four-hour growths of culture 49 were subcultured on agar (September 5), and after sixteen hours' incubation at 37° C. the growth was washed off in saline and the suspension divided into six separate portions.

A was left without further treatment.
B was heated to 60° C. in a water bath for five minutes.
C was heated to 60° C. in a water bath for fifteen minutes.
D was heated to 60° C. in a water bath for thirty minutes.
E was left unheated but was formalized to the extent of 0·5 per cent.
F was left unheated but was formalized to the extent of 0·1 per cent.

TABLE VI.—SERUM B/26.

	Experiment of September 6, 1924.							Experiment of October 10, 1924.						
	1/200	1/400	1/800	1/1600	1/3200	1/6400	1/12800	1/200	1/400	1/800	1/1600	1/3200	1/6400	1/12800
(1) *Readings after* 15 *Minutes' Incubation in Water at* 55° *C.*														
(*a*) No heat..	++++f.	++++f.	++++f.	++++f.	++f.	–	–	++++f.	++++f.	+++f.	++++f.	++f.	–	–
(*b*) 5 min. at 60° C.	–	–	–	–	–	–	–	++++f.	++++f.	++++f.	++++f.	++f.	–	–
(*c*) 15 min. at 60° C.	–	–	–	–	–	–	–	++f.	–	–	–	–	–	–
(*d*) 30 min. at 60° C.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
(*e*) Formalin, 0·5 per cent	++++f.	++++f.	++++f.	++++f.	++f.	–	–	++++f.	++++f.	++++f.	++++f.	+++f.	–	–
(*f*) Formalin, 0·1 per cent	++++f.	++++f.	++++f.	++++f.	++++f.	+	–	++++f.	++++f.	++++f.	++++f.	++f.	–	–
(2) *Readings after* 60 *Minutes' Incubation at* 55° *C.*														
(*a*) No heat..	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.
(*b*) 5 min. at 60° C.	++f.	++f.	++f.	++f.	+	–	–	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.
(*c*) 15 min. at 60° C.	–	–	–	–	–	–	–	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++f.
(*d*) 30 min. at 60° C.	–	–	–	–	–	–	–	++++f.	++f.	++f.	++f.	++f.	+	–
(*e*) Formalin, 0·5 per cent	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	–	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++f.
(*f*) Formalin, 0·1 per cent	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	–	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++f.
(3) *Readings after* 120 *Minutes' Incubation at* 55° *C.*														
(*c*) 15 min. at 60° C.	++	++	++	–	–	–	–	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.
(*d*) 30 min. at 60° C.	++	+	+	–	–	–	–	++++f.	++f.	++f.	++f.	++f.	++f.	+

Culture No. 49 was kept on gelatine and the experiment repeated on October 10, 1924. The results shown in Table VI were obtained :—

This finding can only be explained in the language used to-day thus: That an increase in the thermo-stability of a "constituent antigen" of Culture 49 has occurred during the period September 5 to October 10, 1924, for the same serum was employed in both investigations and the same batch of agar was used in making the cultures. As the same instruments were used and great care taken as to the method of experimentation, the only difference between the two experiments is that one was done on September 6 and the other on October 10.

Can any explanation other than "increase in stability of a component" be given? If we adhere to pictorial representation of the facts the only alternative explanation is that a new "antigen component" has developed in the culture, with the possible production of variants as the result of the passage of time. The other possibility is that the conditions of the two tests *were not exactly similar*. In order to eliminate the possibility of change in the serum being the cause of the different results on the two dates, and to show, if possible, that the particular batch of agar used was not responsible for the results obtained, the following experiment was carried out :—

Three cultures of *aertrycke* bacilli, "High Wycombe," "Glasgow," and "49" were cultivated on plates of the same batch of agar, and were washed off and divided into three portions each.

(1) was left unheated.

(2) was heated to 60° C. for fifteen minutes.

(3) was heated to 60° C. for thirty minutes.

Agglutination tests were then carried out. The results obtained are shown in the following table :—

TABLE VII.—Serum B/24.

(October 11, 1924.)

Readings after 15 *Minutes' Incubation at* 55° *C.*

	1/200	1/400	1/800	1/1600	1/3200	1/6400	1/12800
High Wycombe							
No heat ..	++f.	++f.	++f.	++f.	+	–	–
60° C., 15 min.	–	–	–	–	–	–	–
66° C., 30 ,,	–	–	–	–	–	–	–
Glasgow							
No heat ..	++++f.	++++f.	++++f.	++++f.	++f.	+	–
60° C., 15 min.	–	–	–	–	–	–	–
60° C., 30 ,,	–	–	–	–	–	–	–
49							
No heat ..	++++f.	++++f.	++++f.	++++f.	++f.	–	–
60° C., 15 min.	++f.	–	–	–	–	–	–
60° C., 30 ,,	–	–	–	–	–	–	–

Readings after 60 Minutes' Incubation at 55° C.

High Wycombe

No heat ..	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.
60° C., 15 min.	+	+	–	–	–	–	–
60° C., 30 ,,	+	–	–	–	–	–	–

Glasgow

No heat ..	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.
60° C., 15 min.	++++f.	++f.	+	+	+	+	–
60° C., 30 ,,	++f.	+	+	+	–	–	–

49

No heat ..	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.
60° C., 15 min.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.
60° C., 30 ,,	++++f.	++ ?	++ ?	++ ?	++ ?	+	–

Readings after 120 Minutes' Incubation at 55° C.

High Wycombe

No heat ..	++++f.	++++f.	+++f.	+++f.	+++f.	+++f.	++++f.
60° C., 15 min.	+	+	+	–	–	–	–
60° C., 30 ,,	+	+	+	–	–	–	–

Glasgow

No heat ..	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f
60° C., 15 min.	++++f.	++++f.	++f.	++f.	++f.	++f.	++f.
60° C., 30 ,,	++++f.	++ ?	++ ?	+	+	–	–

49

No heat ..	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f.
60° C., 15 min.	++++f.	++++f.	++++f.	++++f.	++++f.	++++f,	++++f,
60° C., 30 ,,	++++f.	++ ?	++ ?	++ ?	++ ?	++	+

The above results and those shown in Table VI indicate a slow progressive alteration, produced by heat, in physical properties of the suspension rather than an elimination thereby of some one constituent antigen. Moreover, the results show that three strains of *aertrycke* bacilli —their characters had been previously proved by absorption of agglutinin tests—may, when grown on the same batch of agar, exhibit different degrees of thermo-stability. This suggests that the change in behaviour of Culture 49 between September 6 and October 10, 1924, was due really to alteration in that culture and was not produced by influences which depended upon the tests having been conducted upon different days.

The author desires here to express his thanks to Mr. Bruce White for placing at his disposal the High Wycombe and Glasgow cultures (October 8, 1924), together with the information that when supplied they were both "smooth." This was verified, and at the same time verification of the "smooth" condition of Culture 49 was made. As it was possible that Culture 49 had developed group characters during its growth for one month on gelatine, it was tested the following day with para beta serum known to agglutinate *aertrycke* bacilli exhibiting non-specific reactions. The result obtained showed that, as at isolation, Culture 49 was still specific, i.e., it reacted in presence of its own serum in a dilution of 1/12,800 and did not react with the para beta serum in a dilution of 1 in 100. As the results shown in Table VII might have been due to a peculiarity of the

serum employed, the experiment therein described was repeated, using another anti-*aertrycke* serum.

I am indebted to Mr. Bruce White for the supply of this second anti-*aertrycke* serum, which on receipt was marked anti-serum to "Glasgow specific race." The results of the tests were as follows :—

TABLE VIII.—Antiserum to Glasgow Specific Race.

(October 11, 1924.)

	1/200	1/400	1/800	1/1600	1/3200	1/6400	1/12800
15 Minutes' Reading. After Incubation at 55° C.							
High Wycombe							
No heat	++++	++++	++++	++	++	+	−
15 min. at 60° C. ..	−	−	−	−	−	−	−
30 ,, 60° C. ..	−	−	−	−	−	−	−
Glasgow							
No heat	++++	++++	++++	++++	++	++	+
15 min. at 60° C. ..	−	−	−	−	−	−	−
30 ,, 60° C. ..	−	−	−	−	−	−	−
49							
No heat	++++	++++	++++	++++	++++	++++	++++
15 min. at 60° C. ..	++++	++	+	−	−	−	−
30 ,, 60° C. ..	−	−	−	−	−	−	−
60 Minutes' Reading. After Incubation at 55° C.							
High Wycombe							
No heat	++++	++++	++++	++++	++++	++++	++++
15 min. at 60° C. ..	+	−	−	−	−	−	−
30 ,, 60° C. ..	+	−	−	−	−	−	−
Glasgow							
No heat	++++	++++	++++	++++	++++	++++	++++
15 min. at 60° C. ..	++	+	+	+	−	−	−
30 ,, 60° C. ..	++	+	+	+	−	−	−
49							
No heat	++++	++++	++++	++++	++++	++++	++++
15 min. at 60° C. ..	++++	++++	++++	++++	++++	++	+
30 ,, 60° C. ..	++++	++++	++	+	+	−	−
120 Minutes' Reading. After Incubation at 55° C.							
High Wycombe							
No heat	++++	++++	++++	++++	++++	++++	++++
15 min. at 60° C. ..	+	+	−	−	−	−	−
30 ,, 60° C. ..	++	++	+	−	−	−	−
Glasgow							
No heat	++++	++++	++++	++++	++++	++++	++++
15 min. at 60° C. ..	++++	++	++	+	+	−	−
,, 60° C. ..	++++	++	++	+	+	−	−
49							
No heat	++++	++++	++++	++++	++++	++++	++++
15 min. at 60° C. ..	++++	++++	++++	++++	++++	++++	++++
30 ,, 60° C. ..	++++	++++	++++	++	++	+	−

The above result corroborates that obtained when B/24 serum was used and indicates that the result as shown in Table VII was not due to a peculiarity of Serum B/24.

If we are to accept as valid the analysis of antigenic constituents on the basis of their thermo-lability, the results shown in Tables VI, VII and VIII can only be interpreted thus: That the "antigen-mosaic" of these cultures—High Wycombe, Glasgow, and 49—is very different, for some constituents of their antigen pattern behave very differently in all three, High Wycombe having a peculiarly thermo-labile constituent, Glasgow less so, and Culture 49 least of the three.

There is, however (*vide* Table VI) more than a suggestion—indeed, there is almost proof, if we accept the specific receptor hypothesis as valid (cf. Tables VI, VII and VIII)—that the thermo-lability of *one* constituent of Culture 49 had altered during the period September to October 10, 1924. It therefore seems highly probable that all three cultures are essentially the same serologically, but that the influence of heat in altering their PHYSICAL condition is more marked in one case than another.

Heat probably acts by causing progressive hydrolysis of the proteins, and the alteration of physical and chemical state resulting from exposure to heat leads to variation in the degree and quality of the agglutination reactions obtained when heated suspensions are used.

Bearing in mind Besredka's [19] observations on anaphylaxis produced by egg white, on the one hand, and the importance of the physical condition of the reacting systems in agglutination as shown by Northrop and De Kruif [23] on the other, it seems not only unnecessary, but even unprofitable, and indeed confusing, to attempt to analyse micro-organisms into their assumed *constituent antigens*, employing heat to eliminate one or other constituent in the tests.

It could, however, be argued that the experiments quoted are open to criticism, in that the influence of exposure to 60° C. only was investigated, and that this might be a very critical temperature. Such argument loses much of its weight when it is recalled that the heating of a suspension to a given temperature may so alter that suspension that it does not agglutinate in presence of, nor does it remove agglutinins from, a given serum; although that suspension may, nevertheless, on inoculation into animals, stimulate the production of those agglutinins with which it fails to react *in vitro*.

In view of this criticism—that the temperature of 60° C. is a critical one —the following experiment was carried out:—

Cultures of High Wycombe, Glasgow and 49 were made (sixteen hours at 37° C.) and were washed off in saline. They were then divided each into four portions: A, B, C and D.

A was left unheated.

B was heated at 56° C. for thirty minutes.

C was heated at 60° C. for thirty minutes.

D was heated at 65° C. for thirty minutes.

Agglutinations of these four suspensions were then carried out, using serum B/24.

TABLE IX.

Readings after 120 *Minutes' Incubation* 55° C.

High Wycombe

	1/200	1/400	1/800	1/1600	1/3200	1/6400	1/25600
(*a*) No heat ..	++++	++++	++++	++++	++++	++	+
(*b*) 56° C. 30 min.	+++	++++	++++	++++	++++	+++	++
(*c*) 60° C. 30 ,,	+	+	+	–	–	–	–
(*d*) 65° C. 30 ,,	+	+	+	–	–	–	–

Glasgow

	1/200	1/400	1/800	1/1600	1/3200	1/6400	1/25600
(*a*) No heat ..	++++	++++	++++	++++	++++	++++	++
(*b*) 56° C. 30 min.			Accident, not done				
(*c*) 60° C. 30 ,,	++++	++	+	+	–	–	
(*d*) 65° C. 30 ,,	+	+	+	–	–	–	

49

	1/200	1/400	1/800	1/1600	1/3200	1/6400	1/25600
(*a*) No heat ..	++++	++++	++++	++++	++++	++++	++
(*b*) 56° C. 30 min.	++++	++++	++++	++++	++++	++++	++++
(*c*) 60° C. 30 ,,	++++	++	++	++	++	++	+
(*d*) 65° C. 30 ,,	+	+	–	–	–	–	–

It appears, then, that there is an antigen common to these three strains of *aertycke* bacilli, which antigen withstands heating to 56° C. for thirty minutes, but does not stand heating for the same time to 65° C.

If we assume that 60° C. is a critical temperature, so far as these micro-organisms are concerned, we could divide them into constituents withstanding exposure to 56°, but not to 60° C.—thermo-labile constituents, and those withstanding exposure to 65° C. or over—thermo-stable constituents.

If, however, we are to use heat to resolve micro-organisms into their constituent antigens can we, on the above findings, justifiably suggest that these experiments are invalid because they were carriedout at 60° C.? If we do, then applied to the above tests the terms stability and lability are seen to have only a relative significance, for one of the three strains to a large extent withstood heating to 60° C. The assumption that 60° C. is a critical temperature in this connexion is therefore invalid so far as *in vitro* work is concerned, and we know that in *in vivo* work the terms stable and labile have practically no significance, as boiling in a reflux condenser may fail to remove the floccular agglutinogens, as tested by *in vivo* experiments, although heating to 70° C. will usually eliminate these, as determined by *in vitro* tests.

The only logical position for those investigators who accept the view that we can, by means of heat, make an adequate, or indeed any, analysis of the antigens of the three strains dealt with in Table IX is that in Culture 49 there is present an additional antigen not found in the other two and characterized by its relative thermo-stability at 60° C. Let us accept this as an explanation and conduct a similar set of experiments, using, however, *Bacillus paratyphosus* beta and its antiserum instead of the *aertrycke* bacillus to determine whether, as an explanation, this is applicable to other micro-organisms. The experiments shown in Table IX, using *aertrycke* bacilli, were exactly repeated (Table X) with *Bacillus paratyphosus* beta strain 3297.

TABLE X.

Para B Serum 3297 v. Para B Bacilli 3297.

	1/100	1/200	1/400	1/800	1/1,600	1/3,200	1/6,400	1/12,800
15-minute Readings.								
No heat	+	+	+	+	–	–	–	–
56° C. 30 min...	+	+	+	+	–	–	–	–
60° C. 30 ,, ..	+	+	+	+	–	–	–	–
65° C. 30 ,, ..	–	–	–	–	–	–	–	–
60-minute Readings.								
No heat	++++	++++	++++	++++	++	++	+	–
56° C. 30 min...	++++	++++	++++	++++	++++	++++	++	+
60° C. 30 ,, ..	++++	++++	++++	++++	++++	++++	++	+
65° C. 30 ,, ..	–	–	–	–	–	–	–	–
120-minute Readings.								
No heat	++++	++++	++++	++++	++++	++++	++	+
56° C. 30 min...	++++	++++	++++	++++	++++	++++	++	+
60° C. 30 ,, ..	++++	++++	++++	++++	++++	++++	++	+
65° C. 30 ,, ..	+	+	+	–	–	–	–	–

The experiment shown in Table X was repeated six times, using two different serums and three different strains. Exactly comparable results have been obtained in each instance except for differences in the titre of the sera used. The results shown in Tables VI, VII, VIII, IX and X could therefore be interpreted thus: That the labile antigen of *aertrycke* bacilli is somewhat more labile (elimination between 56° C. and 60° C.) than the corresponding antigen of *B. paratyphosus* B (elimination between 60° C. and 65° C.).

If it is valid to base an analysis of the antigenic constituents of a micro-organism upon the thermo-stability or lability of these we should conclude, as has been done by several authors, that the specific antigens of the group of bacteria under discussion are labile, i.e., the specific antigens of the group are those concerned in floccular agglutination. This, however, is not strictly true, for one can obtain floccular agglutination on exposing suspensions of certain of these micro-organisms to heterologous serum (*vide* Table VI).

This means, then, that we cannot correlate the thermo-lability of a given antigen with specificity of agglutination and, therefore there are, in the group of micro-organisms under discussion, two kinds of labile flocculating antigens—specific and non-specific.

A tempting analogy at once presents itself, viz., that the changes produced, when micro-organisms are exposed to heat, have their counterpart in the different coagulation temperatures, and in the differences of susceptibility to salting out exhibited by different proteins. Thus the labile antigen might be visualized as akin in some ways to globulins, and the stable antigens as akin to albumins. There is no real objection to such a view of the thermal reactions of "constituent antigens" except that it cannot be proved or disproved. In order to obtain the constituents separate from one another we should have to break up the organisms: these are visible jelly-like particles remarkably adaptable to variations in osmotic pressure, so that the process would involve the use of harsh and crude methods of separating the

constituents, and they (the constituents) would almost certainly be modified by the procedures employed. The obvious exception to this statement—removal of flagella by simple physical methods as done by Orcutt [3]—has already been noted, but it is recalled here that the results of Orcutt's experiments constitute one of the most serious difficulties met with in accepting as valid the receptor analysis method.

The contention of the author is, then, that the influence of heat upon organismal protoplasm is progressive and acts upon *all* the components of the micro-organism, which components are not separable from one another, and which, taken together, constitute the organism ; for, owing to micro-organisms being formed structures of peculiar physical quality we cannot deal with them as we can with, for example, serum. We cannot readily, at least, separate them into proteins of different kinds in the same sense that the globulins of serum can be separated from the albumins of serum.

Instead of postulating a separate antigen for each observed reaction we might postulate that there is but *one* antigen—the whole micro-organism—and that differences in quality of reaction obtained after exposure of the organisms to heat, are due to alterations in the physical state of the one antigen.

The following experiments indicate that the above hypothesis is worthy of consideration in that exposure to heat may not only inhibit reactions but may even have the reverse effect of increasing the degree of agglutination.

A recently isolated culture of *B. paratyphosus* beta (No. 3297) was washed off, divided into nine portions, four of these portions were heated to 60° C. for varying times, one portion was left untreated, and the other three were formalized to the extent shown in the following table. The serum used was prepared from a stock strain of *B. paratyphosus* beta, which had been in culture for several years, so that it probably contained antibodies to both rough and smooth forms, and did contain antibodies to specific and group phases.

TABLE XI.

(September 9, 1924).

Culture 3297 (*smooth specific*) *v. para B serum.*

Reading after 60 *Minutes' Incubation at* 55° *C.*

	1/100	1/200	1/400	1/200	1/1600	1/3200	1/6400	1/12800
(*a*) No heat	++	++	++	++	+	–	–	–
(*b*) 5 min. at 60° C. ..	++	++	++	++	+	–	–	–
(*c*) 10 ,, ,, 60° C. ..	++++	++++	++++	++++	++	–	–	–
(*d*) 15 ,, ,, 60° C. ..	++++	++++	++++	++++	++	–	–	–
(*e*) 20 ,, ,, 60° C. ..	++++	++++	++++	++++	++	–	–	–
(*f*) 30 ,, ,, 60° C. ..	++++	++++	++++	++++	+	–	–	–
(*g*) Formalin in 0·1 per cent	++++	++++	++++	++	+	–	–	–
(*h*) ,, ,, 0·8 ,, ,,	++++	++++	++++	++	+	–	–	–
(*i*) ,, ,, 1 ,, ,,	++++	++++	++++	++++	+	–	–	–

Reading after 90 *Minutes' Incubation at* 55° *C.*

(*a*) No heat..	++	++	++	++	+	–	–	–
(*b*) 5 min. at 60° C. ..	++++	++++	++++	++++	++	–	–	–
(*c*) 10 ,, ,, 60° C. ..	++++	++++	++++	++++	++	–	–	–

The results with suspensions (*d*), (*e*), (*f*), (*g*), (*h*) and (*i*) after ninety minutes' incubation were substantially the same as those after sixty minutes. Similar, though perhaps less striking, results were obtained on four further occasions with two other strains of *B. paratyphosus* beta and two other sera. On one of these occasions the result was obtained using the serum of an animal immunized against a specific strain, while the strain used in the test was also a specific strain, so that the effect is apparently not due to the presence of group components in the antigen or antibody. It may, therefore, be concluded that the finding shown in Table XI is not very exceptional. A similar experiment was carried out on January 6, 1925, with *aertrycke* bacilli, the technique being modified in that the suspensions were heated to 56° C. instead of 60° C., and the times of exposure were twenty minutes and forty minutes. The anti-*aertrycke* serum used in this experiment was prepared from a specific strain, and a smooth specific culture was used for the tests.

The results are shown in Table XII.

TABLE XII.—ANTI-AERTRYCKE SERUM 3183. INCUBATED AT 55° C.

	1/100	1/200	1/400	1/800	1/1600	1/3200	1/6400	C.
15-minute Readings.								
High Wycombe smooth specific strain								
No heat	++	++	+	+	−	−	−	−
20 min. 56° C. ..	++	++	+	+	−	−	−	−
40 ,, 56° C. ..	++	++	++	+	+	−	−	−
49 smooth specific strain								
No heat	++++	++++	++++	++	+	−	−	−
20 min. 56° C. ..	++++	++++	++++	++++	++	+	−	−
40 ,, 56° C. ..	++++	++++	++++	++++	+	−	−	−
30-minute Readings.								
High Wycombe smooth specific strain								
No heat	++	++	+	+	+	−	−	−
20 min 56° C. ..	++++	++++	++	+	+	−	−	−
40 ,, 56° C. ..	++++	++++	++++	++++	+	+	−	−
49 smooth specific strain								
No heat	++++	++++	++++	++++	++++	++	−	−
20 min. 56° C. ..	++++	++++	++++	++++	++++	+	−	−
40 ,, 56° C. ..	++++	++++	++++	++++	+	−	−	−

Table XII therefore shows a similar slight difference between the unheated and the heated suspensions, as was noted with the *B. paratyphosus* beta strain 3297 heated to 60° C., but only in the case of the Wycombe strain. Differences, well seen after thirty minutes' incubation, were less marked after sixty minutes, and were negligible after 120 minutes. The finding does show however that heating a suspension of some strains of *aertrycke* bacilli may, under certain conditions, increase slightly their flocculability in presence of immune serum.

Note.—It will be observed that the results in Table XII do not strictly agree with those in previous tables, but as different sera were used the significance of this difference is doubtful.

Three possible explanations of the findings shown in Tables XI and XII can be given, two—(*a*) and (*b*)—based on the hypothesis that "receptor analysis" is valid, and one—(*c*)—in which we need not invoke that hypothesis.

(*a*) That by heating we have increased in quantity the flocculating antigen.

(*b*) That by heating we have reduced or rendered inert a factor (? an antigen) which inhibits flocculation.

(*c*) That by heating we have so altered the physical condition of one of the reagents that flocculation takes place more rapidly.

The third explanation (*c*) is simple, and is quite as adequate as (*a*) or (*b*). It cannot be accepted, however, by those who hold that the process of antigen analysis based upon thermo-stability of various components is valid : To be consistent they must either accept the view that heating may, under certain conditions, destroy an inhibiting antigen or create a new antigen, so adding yet another complexity to the already sufficiently complex pattern conjured up by the pictorial representation of the phenomenon under discussion.

It may be argued, from the experiments of this section, that analysis of the (presumed) antigenic pattern of micro-organisms by the use of heat is invalid for the following reasons, major and minor :—

Major Reasons :—

(1) The terms thermo-stability and thermo-lability are only relative. Moreover, a given strain of a micro-organism may vary from time to time as to the thermo-stability of one of its "antigens" (see Table VI).

(2) The terms are so *very* relative that they almost cease to have meaning when *in vivo* methods of testing for the presence of a given antigen are compared with *in vitro* methods of testing for presence of the same antigen.

(3) Thus "antigens" which are alleged to withstand heating to approximately 100° C. need not necessarily be separate thermo-stable constituents, but may well represent all the constituents of the micro-organism, modified, however, by heat. They admittedly differ immunologically from micro-organisms not so treated, but the difference is probably of the same order as that shown to exist in respect of anaphylaxis between raw and boiled egg white.

The fact that serum—i.e., a *known* mixture of different kinds of easily separated proteins—behaves in the same way as does egg white is worthy of note.

Minor Reasons :—

(1) The specific antigen of one group of micro-organisms appears to be associated with the thermo-stable, while that of another is associated with the thermo-labile constituents of the group.

(2) We should have to postulate the existence either of an antigen exhibiting inhibitory qualities but susceptible to heat, or of one which is

produced as a result of heating, if we are to explain the findings shown in Tables XI and XII in terms of thermo-stability of constituent antigens.

(3) The correlation between flagellar (or similar) antigen with thermo-lability and the flocculating type of clumping, on the one hand, or the converse correlation between somatic, thermo-stable and granulating antigens, on the other, is by no means complete.

Lest the views of the writer be misunderstood concerning the occurrence of a multiplicity of antigens in a single living structure, it should be noted that it is realized that indubitably one can, at least in higher forms of life, differentiate one kind of protein from another, and even one histological structure from another, by serological methods.

The investigations dealing with this point are interesting. They show, on the one hand, that distinct antigens occur in a single species, as is exemplified by the multiplicity of antigens in mammalian serum (Dale and Hartley, *Biochemical Journal*, 1916, vol. x, p. 408), and they show, on the other hand, that common antigens occur in quite unrelated species. The observations of Mörner (*Zeit. f. Physiolog. Chem.*, 1894, vol. xviii, p. 61), that there were two types of proteins in the crystalline lens led to the further investigation of these proteins by Hektoen and Schulhof (*Journ. of Infectious Diseases*, 1924, vol. xxxiv, p. 433), using serological methods. These investigations showed that the two lens proteins were immunologically distinct from one another, but each was immunologically identical with the corresponding protein of the crystalline lens of even remote species. A similar immunological relationship exists between the caseins derived from the milk of different animal species.

We have, therefore, two examples of immunological relationships. One markedly specific in relation to the species, and the other entirely lacking in such specificity. The former has been used for investigating genetic relationships—the precipitin tests—but the latter obviously cannot be used for this purpose.

In the case of the bacteria, even if there be a multiplicity of antigens, we cannot, owing to lack of differentiation in structure, really separate them one from another, and so perhaps determine their relationships to the phylogenesis of these low forms of life.

Another thought arises from the consideration of the immunology of lens proteins, viz., that it seems probable that the change produced by boiling of proteins will be of a more profound nature than that which determines the differentiation of the lenticular substances from the other tissues of the same animal. Indeed, we *know* that coagulation of an animal's own proteins *in vivo* leads to their removal as foreign bodies—a process that is seen in the healing of a variety of lesions involving coagulation of the affected area. In view, then, of these considerations it seems somewhat premature to attempt to investigate bacterial genetics by serological methods.

(*To be continued.*)

MOVEMENT OF TROOPS BY SEA.

By Captain and Quartermaster G. A. COLLIER.
Royal Army Medical Corps.

Arrangements for making a Ship habitable for Troops and Families proceeding abroad.

The provision and control of sea transport for military forces is the duty of the Board of Trade. (King's Regs., para. 1082; Field Service Regs., vol. i, sec. 129; Field Service Pocket Book, sec. 27, 1926.)

The Transport Service Regulations, 1915, contain the details of the structural alterations to be made and ventilation requirements to be provided by the owners when preparing a ship for the conveyance overseas of troops and their families.

These regulations were further considered by the Ministry of Shipping, the Admiralty and the War Office, and certain improvements introduced with Treasury sanction for the conveyance of troops by sea. A Circular Memorandum (120/Gen. No./8711) embodying the details was sent to all commands at home and abroad in October, 1920.

The circular contains instructions for special inspection; hammock accommodation; ablution places and latrines; ventilation of troop decks and cabins; shower baths; diet scale; disinfectants; special cutlery for V.D. patients; berthing of children and infants.

Appendix II to the circular gives instruction regarding hygiene on transports and deals with methods of ventilation, construction of latrines and urinals, ablution places, hospitals (general, isolation, and for women, with bath and w.c. adjoining when ten berths are fitted), steam disinfecting chamber, and the water supply.

Special attention is to be given to the problem of securing adequate ventilation for all the troop decks, cabins and necessary buildings, viewed from the standpoint of the supply of fresh air as well as from that of lowering the apparent temperature by means of circulating fans.

Revised specifications (including notes on ventilation and water services) for fitting transports for long engagements, and for fitting freight ships for short engagements, were published in January and February, 1925, as Appendices to Sea-transport Regulations.

In ships appropriated for voyages to the East, electric fans are to be fitted in all cabins: first, second and third class.

A complete set of double awnings, with curtains at the sides, are to be fitted.

Ships for transport service must have and produce the Board of Trade Passenger Certificate.

Cabins for passengers must not be less than six feet in height from deck

to beam, and should have, as a rule, the following deck space: For a second-class cabin to hold 1 person 30 superficial feet, 2 persons 36, 3 persons 50, 4 persons 62, 5 persons 72, 6 persons 84 superficial feet.

The total number of men to be accommodated is to correspond with the actual number of efficient hammock billets plus twenty-five per cent.

Height between decks.—As a rule men will be berthed on decks having a clear height of 6 feet 6 inches below beam.

When the space between decks is less than 6 feet 6 inches special attention must be paid to keep them well ventilated.

Men will not be berthed between decks having less height than six feet.

Men will not be carried upon unsheathed iron decks or under iron exposed decks.

The hammocks are arranged on an interlocking system detailed in the specification by the Transport Department, dated February, 1925. The billets are arranged to give a space of 27 inches between the hammock hooks; each alternate hammock being 4 feet 6 inches from the head of the one on either side with the view of minimizing the risk of mouth-to-mouth infection.

The number of mess tables provided is sufficient to accommodate the full number for which the ship is fitted and in lengths sufficient to allow a *minimum* of twenty inches for each man.

A table is not to exceed fifteen feet in length, i.e., sufficient for eighteen men.

The list of articles provided for mess utensils is printed on the back of the mess roll. (King's Regs., para. 1141; Transport Regs., Appendix XIII.)

Two bread cutters are supplied and fixed on special tables, 4 feet 6 inches by 2 feet 3 inches, of light scantlings, on the mess decks.

Two butcher's tables are provided for cutting up meat; the top of each table to be made of four-inch English elm or English ash, planed top and bottom.

The wash basins for troops are provided in the proportion of four per cent for troops plus three for serjeants.

Canvas baths, each measuring 16 × 5 × 4 feet are supplied to every transport for use of men on deck, one for 500 men, and two if over 500 men are embarked.

Shower baths are provided: two per cent for troops plus two for serjeants. One half of the number to be fitted with hot and cold water supply, the remainder with cold salt water only. "Showers" will generally be available at all times. (King's Regs., para. 1209.)

Latrines: the scale is four per cent for 300 men, with an additional two per cent for each 100 men over 300; two seats extra for serjeants. Urinals are fitted along the inside of the whole length of the latrines.

Two slop shoots are provided on the upper deck, one forward and one aft, to discharge overboard.

A high-pressure steam disinfector (usually Manlove and Alliott or McWhirter), supplied by the Government, is placed on the upper deck as far aft as possible. A poster is provided in the disinfecting chamber describing the working of the apparatus.

When the ship is ready for sea, prior to the embarkation of the passengers, it is inspected by a board consisting of representatives of the Board of Trade and the War Office.

The board ensure that the fittings, sanitary conditions and arrangements for the accommodation, preservation of health and messing of the troops are satisfactory and that the ship is clean and in every way fit for the embarkation of troops. A report prepared by the Board of Trade representative and signed by the Embarkation Staff Officer and the Embarkation Medical Officer is forwarded to the War Office for the information of the Director of Movements and Quartering and the Director of Hygiene.

The crews of transports will be medically inspected and a sanitary inspection of the parts of the ship occupied by the crew will be made by the Embarkation Medical Officer.

A final inspection is made as soon as the embarkation is complete. The O.C. troops, the S.M.O. and the master of the ship will accompany the board at this inspection. (King's Regs., paras. 1082, 1083, 1084 and 1085.)

Special Arrangements for Women and Children.—Families, when practicable, will be on board and berthed before the arrival of the troops. (King's Regs., para. 1152.) A notice, " Routine for Women," is exhibited in every cabin.

The families are provided with berths in cabins having not more than six berths in each. Children, at present, will be berthed on the following scale: children between 1½ and 6 one half berth; children over 6 one complete berth. Children under 1½ are not allotted to berths, but hanging cots will be provided in all troop transports on the following scale: first and second class, five per cent of the total accommodation provided. Third class, 12½ per cent of the third class family accommodation provided. Boys and girls between 6 and 8, and children of different families, are not to be berthed together.

The scale of bedding is: 1 bed, 1 pillow, 2 blankets, 2 sheets, 1 pillow cover, also 1 waterproof sheet, for each family berth.

Stewardesses acting as matrons, under the orders of the master, assist in settling the women and children in their quarters and generally look after their comfort, especially those who are suffering from sea sickness.

A sitting room is arranged between cabins, in which are placed occasional tables and six cane chairs for each table. A drying room is provided and fitted with a steam radiator for drying the children's clothes. A food preparation room, with a sterilizer for children's bottles and teats, where mothers can prepare the infants' food, is provided.

A separate wash place with fresh water laid on is placed near the cabins; one bath is fitted with fresh water service and the others with salt water; steam jets heat the water.

Separate latrine accommodation adjoining the women's cabins is arranged to a scale of four seats per 100 berths plus two portable seats for children.

Sanitary dustbins three feet high and twenty inches diameter are supplied to receive tea leaves and other waste solid matter.

A sufficient number of suitable deck seats are to be provided and secured on the weather deck.

A scale of equipment, cleaning articles and disinfectants for troop families' accommodation, is given in an appendix to the Transport Regulations.

Stores and Equipment.

The owners are required to provide the following disinfectants: Formalin and glycerine; chloride of lime for water sterilization; cresol solution[1]; corrosive sublimate solution. (Transport Regs., Appendix XV.)

Formalin has been substituted for chlorine as a disinfecting agent.

The General Officer Commanding, when a hired transport is to sail from a port in his command, is responsible that the stores laid down in the Equipment Regulations, Part I, and Regulations for the Medical Services of the Army, are placed on board before the troops embark. (King's Regs., para. 1086.)

The Officer Commanding, Army Medical Store, Southampton, will provide the necessary medical equipment.

The list of these stores is included in Regulations A.M.S., Appendix XXXI:—

Sub-head (*a*) for Indian transports.

Sub-head (*b*) for other than Indian transports.

The latter scale is supplemented when women and children are embarked; the list of instruments and appliances issued is given under sub-head (*d*.)

It is the duty of the Embarkation Medical Officer to see that these stores have been put on board and that the medical arrangements are satisfactory. (Regs. A.M.S., para. 560.)

The Chief Ordnance Officer nearest the port of embarkation will cause the stores mentioned in Appendix III of the Equipment Regulations to be placed on board and the O.C. troops on the transport will satisfy himself that the authorized proportions of equipment and clothing have been received. (Equipment Regs., paras. 129, 130 and 132.) The appendix referred to contains a number of items from which are extracted the few which are pertinent to this subject: Stretchers, 1; formaldehyde in Winchester quarts, 2; disinfectors, spray, Mark II, 1.

The following articles of clothing will also be placed on board:

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[1] If a mixture is made of cresol and *fresh water* of a strength of 1 in 5 (and not exceeding this proportion) precipitation does not occur. This mixture can then be diluted down with sea water as required.

helmets, Wolseley pattern, 100; khaki drill suits, 100; service dress suits, 50; canvas shoes, 100; service dress caps, 50. (A.C.I. 416 of 1924.)

For each transport with exposed sentry posts: frocks, oilskin, 4; hats, sou'wester, 4; trousers, oilskin, 4.

Soldiers' families embarking for India should, if possible, be in possession of sun helmets suitable for tropical climates in time for them to be taken into wear during the portion of the voyage east of Suez.

Stocks of sun helmets, supplied by the Government of India, are held at Southampton, where issues are made (on repayment) to families not already in possession of suitable headgear before they go on board. Helmets are also available at Bombay and Karachi for issue, immediately on landing, to families who travelled from ports other than Southampton. (A.C.I. 468 of 1926.)

All persons travelling to the Punjab or other parts of Northern India are advised to provide themselves with additional blankets and warm clothing as a very considerable drop in temperature is experienced north of Delhi during the months November to March.

Messing Arrangements.

Copies of the messing scale and scale of medical comforts and equivalents will be hung up in the issuing room and on each troop deck. (King's Regs., para. 1207.)

The food for men and women and children is provided by the owners to a scale given in Appendix XV of the Transport Regulations.

The scale for men is at present:—

Issued every day.

Fresh meat	$12\frac{4}{7}$ oz.
Preserved meat	$1\frac{5}{7}$,,
Fish	5 ,,
Bread	16 ,,
Fresh vegetables	2 ,,
Potatoes	10 ,,
Butter	$1\frac{1}{2}$,,
Tea	$\frac{3}{8}$,,
Sugar	2 ,,
Dried peas or beans	$1\frac{1}{7}$,,
Rice	1 ,,
Oatmeal	1 ,,
Jam, dried fruit, or syrup	$1\frac{1}{2}$,,
Salt	$\frac{2}{7}$,,
Pepper	$\frac{1}{42}$,,
Mustard	$\frac{1}{20}$,,
Pickles	$\frac{4}{7}$,,
Milk, condensed, unsweetened ..	$2\frac{4}{7}$,,
Cocoa	$\frac{1}{4}$,,

If at sea on Christmas Day extra messing can be provided on the authority of the O.C. troops, who usually has a special sum of money to defray incidental expenses for the benefit of the troops. (King's Regs., para. 1198.)

Dinners for the day on which troops embark will be prepared on board. (King's Regs., para. 1135.)

Lime juice and sugar may be issued with the daily ration on the certificate of the medical officer. (King's Regs., para. 1208.)

An extra issue of food and non-intoxicating liquors is made from the ship's stores daily up to the limit of 2½d. in value to each man of the Royal Army Medical Corps appointed for continuous duty with the troops during the voyage.

Special instructions are issued in the case of transports on Indian troop service. (Transport Regs., Art. 127.)

Each man on night duty (including sentries) may be supplied with half a pint of cocoa at about 4 a.m. One pint of ale may be purchased by each man and woman for consumption with the dinner meal. (King's Regs., para. 1210.)

A scale for women and children is included in Appendix XV and provision has been made to provide children between 1 and 5 years of age with fresh milk, or equivalent quantities of dried milk, daily.

To prevent the purchase of spirits, unwholesome fruits, and to exercise supervision over boats alongside, sentries are posted whilst the ship is in port. (King's Regs., para. 1216.)

Troops must be warned that under no circumstances should food or mineral water be purchased on the wharf from native hawkers.

At Port Said four bumboats, under local supervision, are authorized to sell goods to the troops on ships passing through that port.

Embarkation.

The conditions of age and service for the selection of other ranks proceeding with units and drafts from home stations to, or moving between, overseas garrisons are published annually as Army Council Instructions.

Briefly, enlisted boys, 15 years of age, who have completed three months' service will be eligible for drafting abroad, excepting drafts to Iraq and Aden.

Bandsmen and acting-bandsmen over 18 years of age may embark if they volunteer for service abroad.

Men of 18 years of age, and with at least three months' service, may proceed to Gibraltar and Malta. When 19 years of age and with three months' service, they may be sent to Egypt and Sudan, Bermuda and Jamaica; with six months' service, to Ceylon, Mauritius and China. When 20 years of age and with three months' service, they may be sent to Sierra Leone; with six months' service to Malaya; with twelve months' service to India, Iraq and Palestine.

The age and service qualification is relaxed for India, Iraq and Sierra Leone when men proceed with a unit.

Before proceeding on embarkation furlough, or at least one month before the date of embarkation, the officer in medical charge of the unit will examine all warrant officers, N.C.O.'s and men. Only those fit to serve in the climate for which they are destined will be selected for embarkation. (A.C.I., 797 of 1920.)

The men must also have passed the dental officer's inspection.

These persons are again medically examined on the day of departure from the station. (King's Regs., paras. 1092 and 1094.)

The medical history sheet of each person is completed with entries regarding the soldier's fitness for service overseas; with the result of vaccination; particulars of inoculation. Entries are also to be made in the soldier's pay-book (A.B. 64) regarding vaccination and inoculation. Army Council Instructions, No. 46 of 1924, 17 and 396 of 1926, direct attention, and enjoin strict compliance by all officers commanding units and officers in medical charge of troops, to the King's Regulations, para. 1092, and Regs. A.M.S., paras. 397, 410, 461, 592 (*d*).

The officers commanding units and officers in medical charge of troops are to make every endeavour to ensure that every officer and soldier is inoculated, and that every facility is afforded to all persons who have been warned for service abroad to obtain protection by inoculation against the enteric group of disease.

To draw the attention of officers, soldiers and their families to orders with which they should be acquainted before embarkation suitable extracts from the King's Regulations will be published in Regimental Orders. (King's Regs., para. 1089.)

An inoculation state (A.F.I. 3956) is submitted to the Director of Pathology and to the D.D.M.S. of the Command, one day prior to the departure of the personnel for embarkation. A third copy (with nominal roll of unprotected officers, other ranks, women and children) accompanies the unit, draft or individual embarking to be handed to the embarkation staff officer. (King's Regs. paras. 1091, 1097; Regs. A.M.S. Appendix IV.) The pamphlet, "General Instructions for the Guidance of Individual Officers proceeding Overseas on Change of Station," emphasizes the value of inoculation and re-vaccination.

An officer's wife proceeding in any vessel conveying troops will be required to produce a medical certificate (A.F.B. 155), which should be dated within three days of embarkation, showing that she (and her children and servants, if any) is free from infectious disease, and in all respects medically fit to embark. (King's Regs., para. 1147.)

In the pamphlet, "General Instructions for the Guidance of Wives and Families of Officers proceeding Overseas on Change of Station," the necessity for medical inspection, vaccination and inoculation is brought to the traveller's notice.

A leaflet (A.F.B. 147), "Preliminary Warning Orders and Instructions for the Guidance of Second and Third Class Families proceeding Overseas,"

accompanied by A.F.B. 155, is sent to soldiers' wives who are about to proceed overseas to join their husbands.

Every woman and child will be medically examined within three days of the date of embarkation, and unless provided with a health certificate (A.F.B. 155) will not be permitted to embark. (King's Regs., para. 1150.)

Families are not allowed to proceed to Iraq or the Sudan.

Daily Routine.

On the day following embarkation, soldiers will be inspected by the medical officer. He will ascertain the state of protection of the troops and families on board against small-pox. He will inoculate or vaccinate all those not efficiently protected who are willing to be inoculated or vaccinated.

In every transport the officer in medical charge will be responsible for the medical and sanitary control of the whole ship and personnel.

The medical officer will take sanitary and medical charge of the ship and crew, and will frequently inspect the quarters occupied by the crew. He will take great care that the bilges are kept sweet, and that as good a sanitary condition as possible is maintained. (Transport Regs., Art. 134, and King's Regs., para. 1178.)

A lecture on ventilation and general ship hygiene should be given to the troops at the beginning of the voyage.

The following health memoranda are placed on every ship conveying troops : "Health Memoranda for British Soldiers in India"; "Notes for the Preservation of the Health of Women and Children Proceeding to India and other Tropical Countries" (A.F.B. 51a); "Prevention of Influenza"—leaflet.

It is the duty of the medical officer to explain clearly the subject matter of these publications to all concerned.

Appendix "G," "Notes and Instructions for O.C. Troops on Transports to India," is a summary of precautions to be observed by soldiers travelling by rail in India.

The C.O. will ascertain from the master the hours at which he wishes to make his daily inspection of the ship. The C.O., accompanied by the officer in medical charge, will, at the same time, inspect all parts of the vessel appropriated to troops. The cabins are to be vacated daily at a fixed hour for cleaning and inspection. Salt water will not be thrown on the troop decks; they are to be scrubbed with hand-scrubbers and soap, and dried with flannels provided for that purpose. If the men cannot go on deck owing to inclement weather, the troop decks are to be sanded with hot dry sand and well swept. Troop decks are swept after hammocks are down, and before and after each meal. (King's Regs., paras. 1170, 1186 and 1202.)

It is desirable to appoint a N.C.O. as sanitary serjeant to be responsible

for all latrines, washhouses, etc., and to supervise fatigue parties detailed for those parts of the ship. (King's Regs., paras. 1144 and 1201.)

The latrine seats should be scrubbed daily with a disinfectant. The interior of the latrine should be washed down with disinfectant periodically.

Notices are posted prohibiting improper use of the closets and latrine troughs.

A hammock with bedding is issued for each N.C.O. and man. The leather hammock tally on each set of bedding is to be clearly marked on the day of embarkation with the name of the soldier, the number of his mess and his messing number.

Steps are to be taken to ensure that each set of bedding is used throughout the voyage only by the individual to whom it is issued on embarkation.

Hammocks are to be taken down and stowed at 6 a.m. (King's Regs., paras. 1140 and 1176.)

Sleeping on deck should be encouraged whenever weather and climate are suitable.

When sleeping on deck is permitted, bedding will only be allowed there during the hours fixed by the commanding officer and master of the ship. The men's bedding is to be aired as frequently as possible, especially in hot weather. All bedding and boxes are to be taken on deck once a week to be aired, if weather permits, and the berths and quarters scrubbed with hot water and soap. The bed linen of the first and second class passengers is changed once a week. The sheets and pillow covers issued for third class passengers are changed after each ten days of the voyage. (King's Regs., paras. 1139, 1192, and 1196.)

Note.—When troops proceed by a cross-Channel route a part-worn blanket or rug may be issued to each soldier and to each member of the family of a soldier on the married roll. (King's Regs., para. 1070.)

The troops' hammocks and blankets are disinfected and washed after each voyage.

In order that troops may disembark in a fit condition, arrangements will be made to carry out physical training exercises. Sports are encouraged; the O.C. troops has a sum of money for the provision of prizes. Soldiers will not be employed as stewards or in coaling unless the officer in medical charge certifies that their health will not be injured thereby. (King's Regs., paras. 1175, 1191 and 1198.)

Water Supply.

There are two sources of fresh water, distillation in the ship and a shore supply. Contamination of water may occur at the source, during transference to the ship, within the ship. The contents of drinking water tanks should be chlorinated if considered necessary.

Fresh-water tanks must be ventilated and gravity tanks on upper decks should be insulated for all hot weather trips.

The minimum allowance for each person embarked is eight pints per diem, increased to ten pints within the tropics. Water for drinking is available day and night. The inspecting officer is to see that drinking water taps are provided in a prominent position in each compartment fitted for troops, and in suitable positions in troops' families' quarters.

Water for washing will be available between 5.30 a.m. and 8.30 a.m., 11 a.m. and 12.30 p.m., 4.30 p.m. and 6.30 p.m., and for washing clothes as agreed between the O.C. troops and the master. (King's Regs., para. 1209; Regs. A.M.S., para. 440(*e*).)

Special Medical Arrangements.

When venereal cases are embarked they will be provided with separate latrines and washing places and placed in a separate mess. Special cutlery for these cases has been provided, and the mess utensils are marked "V."

The whole of their bedding is to be disinfected after the men have been disembarked.

Instructions regarding the necessary procedure when cases of an infectious nature occur during the voyage are given in King's Regs., paras. 1203, 1204; Regs. A.M.S., para. 570 and Appendix II.

Contacts should, if possible, be disinfected on board. Further instructions regarding the disposal of infectious cases and contacts are given in the instructions for O.C. troops and "Notes for Medical Officers on Transports."

The International Sanitary Convention has issued laws to be adopted at ports in dealing with certain infectious diseases. These are given in Appendix III, Regs. A.M.S.

The clothing and bedding used by the sick, as well as that of all men admitted to hospital, will be disinfected (King's Regs., para. 1200.)

Cabins are to be disinfected (as directed in para. 440, Regs. A.M.S.) after being used by an infectious case. The O.C. troops must certify that this has been done.

Reports by the S.M.O. on the condition of fittings and sanitary arrangements are to be submitted with the voyage report, as directed in para. 52 of the Instructions for Officers Commanding Transports.

The report rendered by the S.M.O. to the D.G., A.M.S., War Office, on completion of the voyage will be confined to details regarding the health of troops and families on board.

Details regarding inoculations are given in Appendix IV of the Regs. A.M.S. and in para. 27 of the Notes for Medical Officers. Inoculation states and a nominal roll of persons vaccinated are required on disembarkation.

Disembarkation.

To ensure that undetected cases of venereal disease are not disembarked an order will be issued and read on parade to all troops within one week of

disembarkation, directing any soldier who is suffering from venereal disease to report himself sick.

A medical inspection will be made of the troops on the day prior to disembarkation. (King's Regs., para. 1178 and Regs. A.M.S., para. 576.)

A certificate is required that all the military passengers are free (or not) from infectious and skin disease.

The troop decks, married quarters, latrines and washhouses are to be cleaned before the troops disembark.

If the weather is inclement on the day of disembarkation a special fatigue party will be detailed to clean up the women's quarters after the families have disembarked. (King's Regs., paras. 1196 and 1220.)

Any outbreak of infectious disease should be specially notified by wireless, stating disease, number of cases and immediate contacts.

When cases of infectious disease have occurred on board a certificate is to be furnished to the disembarking staff officer that all articles capable of conveying infection have been disinfected on board, handed over to the sanitary authorities at the port of disembarkation, or destroyed. (King's Regs., para. 1222.)

Troops under orders to land before dinner will be provided with breakfast only. (King's Regs., para. 1225.)

All water bottles will be filled immediately before final disembarkation.

Pith hats are inspected as the troops leave the gangway.

When stores are returned to "Ordnance" after the voyage, a certificate by the O.C. troops must be given, stating that the articles are free from infection. (R.A.O.C. Regs., para. 570.)

After the troops have disembarked the O.C. troops will inspect the troop decks, etc., to see that they have been cleaned to the satisfaction of the master. (King's Regs., para. 1237.)

Editorial.

ACUTE POLIOMYELITIS.

THE occurrence of three cases of poliomyelitis at the Royal Military Academy, and the contrast between the action taken by the military authorities there and that taken by the headmaster at Uppingham, consequent on an outbreak at the school, has brought into prominence the diversity of the views held by medical men on the best means of controlling the disease.

To the hygienist, poliomyelitis presents many perplexing problems and a consideration of these may be of interest, as undoubtedly the disease is much more prevalent in England than it used to be, and medical officers in charge of military institutions may at any time be faced with the necessity of taking definite action to prevent the spread of the disease.

Before discussing the policy to be adopted on the outbreak of poliomyelitis in an institution, it might be advantageous to mention briefly the main facts now known concerning the cause and mode of propagation of the disease.

The first important outbreak of poliomyelitis occurred in Stockholm in 1887, another appeared in Rutland, Massachusetts, in 1894, and in 1899 a large epidemic was reported in Sweden and Norway. But nothing was known about the virus until 1909, when Lansteiner and Popper succeeded in transmitting the disease to monkeys by intraperitoneal injection of an emulsion of spinal cord taken from a case of the disease. In 1910, Flexner and Lewis transmitted the disease by injections of a similar emulsion into the brain of a monkey. In 1913, Flexner and Noguchi reported the cultivation of small globoid bodies when portions of an infected spinal cord were grown in a mixture of ascitic fluid and fresh kidney tissue under anaerobic conditions. They found that the globoid bodies appeared in the nervous tissue in single or double form. When cultivated, however, chains are seen which, according to Amoss, after twenty days may contain sixteen members forming a U loop. The virus is not present in the blood, either abundantly or constantly. Amoss believes that the globoid bodies fulfil Koch's postulates—they are found repeatedly in the lesions of poliomyelitis in man and the monkey; they are not detected in the lesions of other diseases; they have sufficed in several instances to reproduce the experimental disease in monkeys and have been recovered in the lesion so produced. They stain a violet colour with Giemsa while the ordinary *Streptococcus pyogenes* stains blue; they are Gram-negative and the serum of experimental monkeys agglutinates them very slightly. The serum of recovered human beings shows no complement deviation with the antigen derived from the globoid bodies. According to Amoss, when the strains

have become established they become more and more saprophytic and will grow in the absence of animal tissues, but they lose their pathogenicity. All bacteriologists have not been able to find these organisms in the nervous tissues of infected monkeys. Bull reports many failures to isolate them.

The virus, whether it be represented by the globoid bodies or not, occurs constantly in the brain and spinal cord, and inoculation tests have shown it to be present in the intervertebral, Gasserian and abdominal sympathetic ganglia. It may be found in the subarachnoid space soon after infection, but rapidly disappears from the cerebro-spinal fluid, in which early in the acute stage there is a characteristic lymphocytosis. The virus is also found in the mucous membrane of the nose, throat, stomach, large and small intestine. The distribution is the same in spontaneous poliomyelitis in human beings and in experimental monkeys. Injection of the virus into the brain is the most certain method of causing the disease; the next most certain method according to Flexner is application of the virus to the mucous membrane of the nose. In an infected animal the virus escapes in the secretions of the nose and throat, and with the discharges from the intestine.

An emulsion of the cord from an infected monkey and the centrifugalized emulsion filtered through a Berkefeld filter have the same action but the former acts more quickly: a fraction of a cubic centimetre of the filtrate produces symptoms of paralysis when injected intracerebrally into a monkey. In 1910, Leiner and von Wiesner showed that painting the mucous membrane of the nose of a monkey without producing any lesion, with an emulsion of cord on a camel's-hair brush, caused infection.

According to Flexner and Amoss the virus enters the human body through the upper respiratory passages and in particular through the naso-pharyngeal mucous membrane. Once within this membrane the virus may pass through the lymphatic channels surrounding the filaments of the olfactory nerve to the meninges and reach the cerebro-spinal fluid, or it may first enter the blood and be conducted to the nervous system by the circulation. When the virus is introduced into the nasal mucosa of monkeys, its propagation can be followed from the olfactory lobes to the medulla and spinal cord. The experiments of Flexner and Amoss indicate that the infection in epidemic poliomyelitis in man is local and neural and by way of the lymphatics and not general by way of the blood. They say that when the nasal mucous membrane of a monkey is painted with an emulsion of cord from an infected monkey poliomyelitis follows and in forty-eight hours only the olfactory nerve is affected, the medulla and spinal cord at this time show no sign of infection. If the infection were from the blood the medulla and spinal cord should be affected first as they have greater selective affinity for the virus. The mucous membrane of the nose is believed to be more vulnerable in young people, hence the preponderance of poliomyelitis in childhood.

The distribution of virus by droplets during coughing and speaking appears to be readily accomplished. This is a very important fact from the point of view of the epidemiologist.

The virus of human poliomyelitis seems at first to have relatively weak pathogenic action on monkeys, but after a few passages the infective power rises and reaches a maximum which may be maintained for some three years. Later the infective power gradually falls off and finally may be no greater than at the outset. This succession of phenomena dependent on changes of virulence finds a counterpart in the phenomena noted during the rise, persistence, and fall in the number of cases during epidemics of the disease among men and animals. The fluctuations in virulence are the product of causes acting from within; that is, they are the result of internal rather than external effects.

Sporadic cases may be regarded as carrying a micro-organism of low virulence. The conversion through favourable circumstances of micro-organisms of low into others of high virulence may be the signal for the appearance of epidemics not necessarily confined to one place but possibly rising simultaneously in remote places where conditions are similar.

Coverly was the first person to allude to the possibility of non-paralytic cases of poliomyelitis. In the Rutland epidemic of 1894 he describes six cases without paralysis among a total of 132 typical cases. Wickman, in 1907, emphasized the importance of abortive cases and healthy carriers in the epidemiology of poliomyelitis. Flexner, Clark and Fraser demonstrated the typical virus in the nasopharyngeal washings of healthy persons who had been in close contact with actual cases of poliomyelitis. They injected filtered washings from the upper respiratory passages into a monkey, which became paralysed in a typical manner. An emulsion of the spinal cord of this monkey when injected into a second monkey caused typical poliomyelitis.

Kling and Pattersson have also described similar cases. They concentrated at 35° to 38° C. the nasal washings from the wife and three healthy children of a man who had died from poliomyelitis, added sodium chloride and then filtered the washings through a Berkefeld filter. They injected 0·5 cubic centimetre into the brain and twenty cubic centimetres into the peritoneal cavity of a monkey; paralysis followed accompanied by typical lesions. An emulsion of the cord of this monkey when injected into two other monkeys caused paralysis and typical lesions.

Taylor and Amoss' cases were very significant. A man died of poliomyelitis and a brother after an attack without paralytic symptoms was found to be a carrier of the virus. A sister was found to be a carrier five days before the development of the initial symptoms, which were later followed by paralysis.

The Swedish observers believe that "healthy and chronic carriers arise numerously during epidemics of poliomyelitis and actually exceed, possibly many fold, the number of actual cases of the disease. Moreover the virus

may be persistent in persons who have recovered from the disease and be detectable by animal inoculation several months after the acute symptoms have subsided."

Flexner and Amoss have not been able to confirm the results of the Swedish observers, Kling, Pattersson and Wernstedt, who on the basis of tests with washings from human cases believe chronic carriers of the virus to be common. Flexner and Amoss experimented with tonsils and adenoids removed from cases of poliomyelitis; infection was secured with tissues obtained during the first week of the disease, but not at later periods. Observations made during the great epidemic in New York State in 1916 seem to show that the period of maximum infectivity is relatively brief and greatest early in the disease. The epidemiologists concluded that the "communicability of the disease was a phenomenon of the early stages, while the frankly paralysed person and the convalescent were to be feared much less."

In the Broadstairs outbreak of 1926, the cases ceased almost entirely at the end of a fortnight.

Amoss and Taylor have found that the washings of the nasal and pharyngeal mucous membrane in certain healthy persons has the power of neutralizing the virus of poliomyelitis, but inflammatory conditions of the upper air passages tend to remove or diminish this power. The neutralizing substance is water soluble and thermolabile.

Netter and Levaditi have shown that after recovery from poliomyelitis there are active principles in the blood which neutralize the virus.

The blood of cases of infantile paralysis occurring sporadically in childhood has been found capable of neutralizing the virus of poliomyelitis a mixture of the virus and serum produces no effect when injected into monkeys. Normal serum has not this power. The neutralizing principles have been found twenty years after an attack and probably persist throughout life. This fact accounts for the rarity of second attacks.

Poliomyelitis occurs mainly in summer and autumn months, though dropping cases are found at times throughout the year. The seasonal prevalence suggests that the disease may be conveyed by insects, but this seems unlikely, as the virus, even when injected in large amounts, rapidly disappears from the blood. In one instance only was it found possible to infect a monkey by the subcutaneous route. The blood of human beings and that of infected monkeys is usually non-infective.

Clark, Fraser and Amoss made experiments with *Stomoxys calcitrans.* Over 400 flies were allowed to bite infected monkeys for two to three hours on five consecutive days; they were also allowed to feed ten times on other monkeys, five times before and five times after the onset of paralysis. They were then fed ten times in thirteen days on four healthy monkeys, but these remained perfectly healthy. At the end of the experiment the dead bodies of the flies were then collected and ground up in saline solution which was filtered through a Berkefeld filter. The filtrate when injected intra-

cerebrally into a monkey produced no ill-effects. According to Flexner it has not been possible to infect the head or body louse. Bed bugs were infected in one case only and the virus remained alive for many days.

Culex pipiens raised from the larval stage in water experimentally contaminated with an abundance of poliomyelitic virus has been found to be incapable of causing the infection when allowed in large numbers to bite normal monkeys.

C. pipiens fed on infected poliomyelitic monkeys during different stages of the disease also failed to transmit the infection when allowed in large numbers to bite normal monkeys. Previous disturbances of the meninges by an injection of horse serum into the intrathecal space did not alter the result, which was negative.

The offspring of the mosquitoes which were either reared in the infected tank or fed on infected monkeys were found to be entirely harmless when allowed to feed in large numbers on normal monkeys. There was no hereditary transmission of the virus from one generation to another.

No trace of virus of poliomyelitis was demonstrable in the filtrate of an emulsion of adult flies and pupæ of the common house-fly and blue-bottle fly which were reared in the laboratory on slices, emulsion or filtrate of monkey brain containing the poliomyelitic virus. The intracerebral injection of the filtrate produced no poliomyelitic infection in the normal monkey.

Neustaedter and Thro claim to have found the virus in a viable state in the dust of the sick room and to have produced poliomyelitis in monkeys by means of such dust.

In the New York Health Department's weekly bulletin there is a brief account of ten cases of poliomyelitis which occurred in Cortland in the last quarter of 1925. This is described as "the first outbreak definitely traced to milk." Six of the cases occurred during the third week of December, and seven days prior to the onset of the first case a boy engaged on the farm, milking the cows and otherwise handling milk, had been taken ill with poliomyelitis and continued at work four days after the onset. Of the six cases, five consumed the milk regularly and one casually. Three other cases, however, were reported in October, who took their milk from other sources, and of three others which developed in December only one had consumed the suspected milk. In these circumstances further evidence will be required before the conveyance of poliomyelitis through the agency of milk can be accepted.

In the Broadstairs outbreak of 1926 the Medical Officer of Health reported that the total number of cases was probably not less than sixty-seven. Thirteen private schools, particularly boarding schools, were affected and in these thirty-five children, one mistress and two members of the domestic staff, were attacked. The disease started almost simultaneously in all the schools affected, but did not spread in the elementary schools. This seems to support Dudley's contention that prolonged con-

tact in sleeping quarters is a more important cause of diffusion of infection than the short association in class-rooms.

The experimental and epidemiological observations which we have quoted seem to indicate that the infection in poliomyelitis is conveyed from one individual to another mainly by means of infected droplets from the upper respiratory passages ejected during speaking and coughing. The virus appears to be most infective during the first week or ten days of the disease; it is not so potent in the later stages when symptoms of paralysis have appeared. Cases of undoubted poliomyelitis exist in which there is no paralysis of the muscles, the symptoms being mainly those of an ordinary catarrh with fever. The virus may be present in the nasal mucous membrane *before* any symptoms have developed, and healthy people who have been in close contact with poliomyelitis cases may also carry the virus. There is a difference of opinion as to the duration of infectivity of convalescents from the disease and of healthy carriers of the virus. Swedish observers believe that the virus might persist for many months in convalescent cases and that chronic carriers exist in considerable numbers in every epidemic: they admit, however, that after eight to fourteen days the virus becomes weaker. The American workers consider that infection does not persist much beyond the first week of the disease and that chronic carriers are of exceptional occurrence. Unfortunately we have at present no means of detecting carriers except by resorting to animal experiment. Amoss has found that the virus, represented by the globoid bodies, when cultivated will eventually grow in the absence of animal tissues and then loses its pathogenicity. It might be possible to use such a virus as an intradermal test for the detection of carriers, or at least for the detection of those who are susceptible to the disease, and who according to some observers represent only two per cent of the community.

With our present knowledge we must regard cases of poliomyelitis and those who have been in contact with them as possible centres of infection, and when the disease is prevalent individuals in the affected community who show merely catarrhal symptoms must also be regarded with suspicion. In the first weeks of the outbreak the infectivity appears to be the greatest, and after three weeks, if there have been no fresh cases, the risk of further infection appears to be small. For all practical purposes we may disregard infected dust and insect vectors.

Bearing these points in mind, let us see what actually happened at the Royal Academy, Woolwich. The first case, Cadet Pe—, occurred about October 28, 1926. The early symptoms were those of mild influenza, but on the development of paresis of the palate an examination of the throat exudation was made, when a bacillus morphologically resembling the bacillus of diphtheria was discovered: later, when paralysis of the deltoid muscle occurred, poliomyelitis was diagnosed. In the meantime Cadet R. D., belonging to the same term as the first case, and who had been in constant association with him, was admitted into hospital on October 31 with symptoms of influenza. On November 3 paralysis of the right arm and leg

and the left arm appeared, and the case was diagnosed poliomyelitis. No other case occurred until November 21, when another cadet (Ph—), also of the same term, developed symptoms of influenza when at home on week-end leave. He returned to Woolwich on November 26 and was kept under observation in hospital; later he developed slight paresis of the deltoid and poliomyelitis was diagnosed. Cadet Ph— had sat next to Cadet R. D. at meals on October 28 and 29.

There were no other cases among the cadets, but an officer, Lieutenant B—, R.A., who had been moved to Edinburgh on November 10, developed the disease on that day; he had no immediate connexion with the Royal Military Academy, but was at a boxing match there fourteen days before, when he sat with the officers.

How was the infection brought to the Royal Military Academy? It appears that Cadet Pe— had been on week-end leave before he was attacked with influenzal symptoms, and he might have picked up the virus at either Hythe or Maidstone. But the possibility of a local source of infection cannot be ignored; two cases of poliomyelitis were notified in Woolwich among the civil population in 1926, one in August and one in September, and it is considered probable that there might have been other cases, especially of the abortive type, which were not notified. The case of Lieutenant B— is suggestive in this connexion.

If cases existed in Woolwich, especially among children of school age, the servants of the Academy might act as carriers of the infection, and a careful investigation of the possible association of the children of the married people or of the servants themselves with civilian cases was obviously desirable.

As the incubation period is usually one to four days, Cadet R. D. most probably acquired the infection from his intimate friend Cadet Pe—. The case of Cadet Ph— presents some difficulties; he might of course have acquired the infection when on week-end leave; on the other hand he had sat next Cadet R. D. for two days, and he might have acquired the infection from him, as we know that a case may carry the virus for a few days before the development of the disease. But if we admit this possibility the incubation in the case of Cadet Ph— would be at least three weeks, which seems rather improbable, but not impossible in the present state of our knowledge.

What was the proper course to pursue in the circumstances occurring at the Academy? In view of the action taken at Uppingham, the question of dispersing the cadets naturally required serious consideration. When dispersing a school two questions have to be considered: (*a*) The risk to the members of the school, and (*b*) the risk to the general community. Epidemiological investigations have shown that the intimate admixture of children from different families in a common school is an important factor in increasing infectivity of other diseases. In his experiments on the effect of dispersal of an infected herd, Topley found that while the dispersal of the population at risk in large groups during the pre-epidemic phase had

little influence, dispersal into small groups had a marked inhibitory effect. Dispersal became less effective as the wave of mortality reached its crest, and once the wave began to subside it appeared unlikely that dispersal would have any appreciable influence on the further course of the epidemic.

If an epidemic is commencing and cases are distributed throughout a school, it would appear that in the interests of the scholars dispersal is the right policy.

Now at the Academy the cases were confined to one small group of second term cadets who work and mess together, and each of whom has a separate room. The different terms occupy separate houses, and practically do not mix with one another. The first two cases occurred within a few days of each other, but three weeks elapsed before the third cadet developed the disease, and he on his return was not allowed to mix with the other cadets. In these circumstances it was obvious that an epidemic of poliomyelitis was not developing in the Academy, and as a result of the precautions taken by the Director of Hygiene and the Eastern Command, there was no circulation of non-immunes among the infected community. Cadets of second term were not allowed to gather in each other's rooms after mess. Rugby football and any exercises which bring individuals into close personal contact, and visits to cinemas and other crowded assemblies, were prohibited, and all leave was stopped. Sports fixtures for the whole of the Academy were also cancelled.

The solution of the problem was therefore not dispersal of the cadets, but protection of the Academy from the possible introduction of further infection from outside sources; in other words, to "ring-fence" the Academy and its inhabitants. This was the policy advocated by the members of the Army Medical Advisory Board and representatives of the Directorates of Hygiene and Pathology and the Ministry of Health.

The conditions in our public schools would probably be very different from those at the Royal Military Academy; the boys would not have separate rooms in their houses, there would be prolonged association in dormitories—a potent means of spreading infection, and the members of all the houses would be intimately associated in the various class-rooms. If in such a community cases of poliomyelitis appeared within the usual incubation period in several different houses, then the conditions would be favourable for the development of high epidemicity. Unless arrangements could be made to prevent the spread of "droplet" infection, which in the case of most schools, unlike Woolwich and Sandhurst, would be very difficult, then early dispersal of such a school before the outbreak had assumed epidemic proportions would seem to be the right policy. The risk of spread of infection in good-class homes where each boy could have a separate room in the daytime and a separate bedroom would be comparatively small, and if the dispersal of the school was promptly effected it is unlikely that there would be many new foci of infection formed amongst the general community. The policy to be adopted in each outbreak must depend upon early recognition of the disease and the local conditions.

Clinical and other Notes.

REPORT ON AN OUTBREAK OF FOLLICULAR TONSILLITIS IN MOASCAR CAMP, ISMAILIA, EGYPT.

By Major KENNETH COMYN.

Royal Army Medical Corps.

A SOMEWHAT unusual epidemic of follicular tonsillitis occurred in one of the two infantry battalions at Moascar, Ismailia, in May, 1926.

No other unit was affected to any extent nor were the officers or military families.

Tonsillitis is somewhat prevalent in the locality during the months of March, April and May, probably owing to the frequency of high winds and sand-storms.

The outbreak started in "X" Battalion on May 14, in the afternoon, the first 3 cases being admitted to hospital that evening, and on the 15th 54 were admitted. Subsequently 11 more were admitted on the 16th, 5 on the 17th, 1 on the 18th, and 3 on the 19th.

Owing to lack of accommodation in hospital, milder cases had to be isolated and treated in barracks, the battalion being inspected by companies and throat cases segregated. Thus, on the 15th 17 cases were isolated and treated, 41 on the 16th, 5 on the 17th, and 1 on the 18th.

The last 3 cases admitted to hospital on the 19th had been treated in barracks for three days; the outbreak had therefore virtually ceased on the 18th; only one more admission occurred during the following days, namely, on the 20th, when the orderly, who had been attending the cases in barracks, was sent to hospital with a very mild attack. There had been 78 admissions to hospital, and 64 treated in barracks, total 142 in five days. Ratio per 1,000 strength—169.

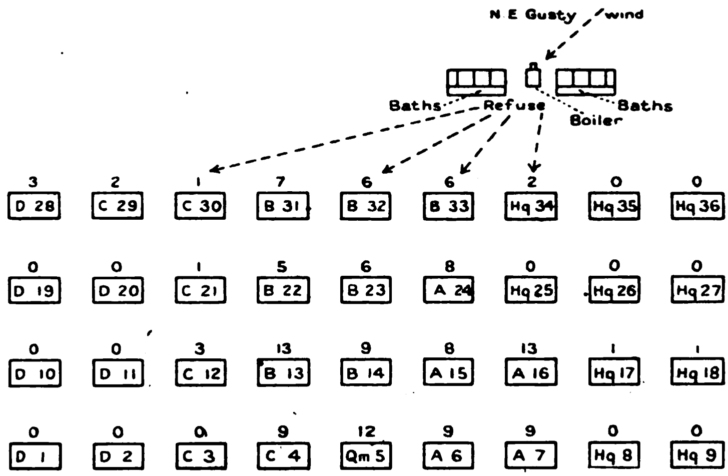
On questioning all these men as to the time of onset of their symptoms, a most remarkable explosive epidemic was revealed.

Of the total, 142, no fewer than 90 started their symptoms in the afternoon of the 14th, 38 on the morning or early afternoon of the 15th, and only 9 on the 16th, there being no fresh cases at all after the 16th, except the one admission on the 20th, of the orderly in attendance on isolation cases at barracks.

On the 25th, after eight days without any fresh cases, a sudden recrudescence of the epidemic occurred, there being 35 admissions in seven days. On inquiry as to the time of onset of symptoms, it was found that the first 2 cases were relapses from the first attack, a third started on the night of the 25th, and 26 on the morning of the 26th, 4 on the 27th, and the last 2 on the 29th, the latter both being relapses from the first epidemic.

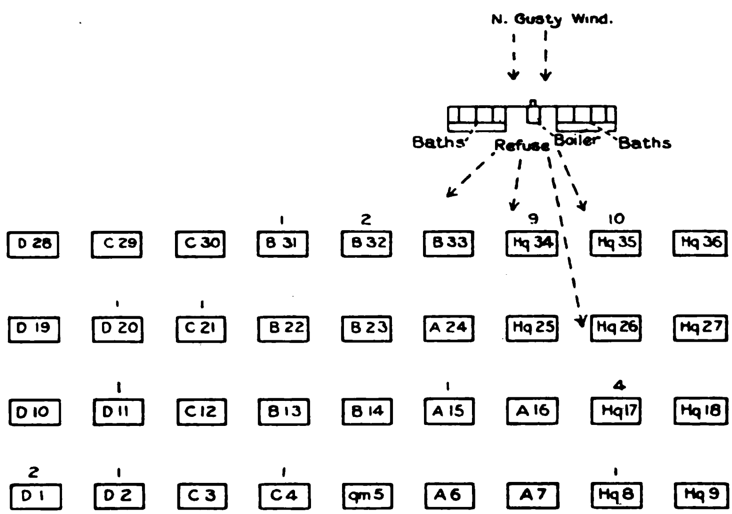
This again showed, though in milder form, the same remarkable explosive character.

What at first appeared to be an important feature in the epidemic was



PLAN OF BARRACK ROOMS. FIRST EPIDEMIC, MAY 14 TO 19.

The letters denote companies. The figures *inside* each "barrack room" denote the number of the room. The figures *outside* a room denote the number of cases occurring in that room.



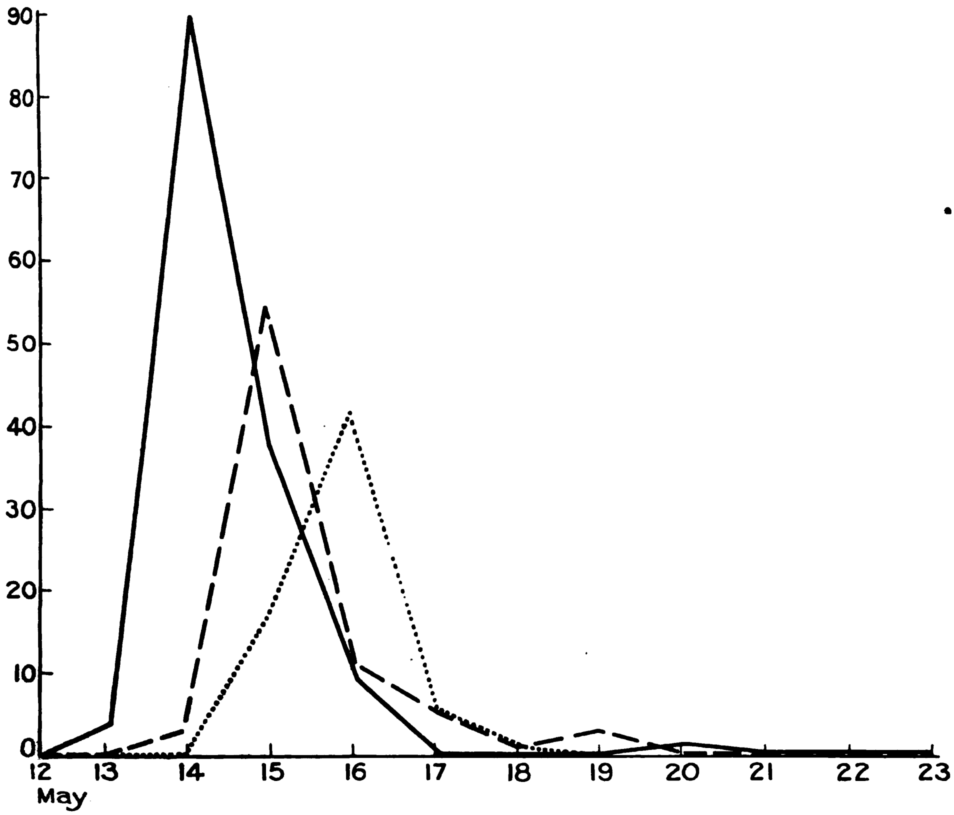
PLAN OF BARRACK ROOMS. SECOND EPIDEMIC, MAY 25 TO 29.

The letters denote companies. The figures *inside* each "barrack room" denote the number of the room. The figures *outside* a room denote the number of cases occurring in that room.

the distribution by companies of the 142 cases in the first outbreak; there were 118 from "A" and "B" Companies, and only 3 from "D" Company, and 1 from Headquarters Company, the remainder from "C" Company,

Transport, Details, etc. Of the 35 in the second outbreak, 24 were from Headquarters Company, as compared with 3 cases that occurred before the 13th, of which 2 were in "D" Company and 1 in Headquarters Company. These facts, coupled with the explosive character of the epidemic, tended to eliminate the possibility of the infection being conveyed by droplet infection from man to man.

A careful investigation followed, considering in turn questions of over-



12th and 13th, strong north wind and dust-storms, afternoon, 5.

——— Total number admitted to hospital and barrack treatment by dates of onset of disease, 144.

— — — Admissions to hospital, 14th to 23rd, 114.

.... Cases isolated and treated in barracks, 15th to 18th, 64.

crowding, ventilation, food, drainage, dining-halls, cook-houses, institutes, bathing, cinemas, etc., all of which were exonerated.

A plan of the barrack rooms was obtained and a spot map of the cases by barrack rooms prepared. Suspicion was then centred upon an area adjacent to the bath-houses, where all the dustbins containing dry refuse from the barrack rooms, institutes and dining-rooms were collected, paper and other consumable refuse being picked out and burnt in the boiler fire

to provide hot water for the baths. The remainder of the refuse should have been removed early in the day, but in practice it was found that the native contractor's carts were invariably late and the refuse was left lying about up to mid-day, the ground around the bath-houses becoming foul and distinctly odorous.

The site was approximately twenty yards to the north of the nearest barrack rooms in the line. Investigation of the direction of the wind and prevalence of dust-storms about this time revealed that there were strong gusty winds accompanied by sand-storms and dust-storms in the afternoons of May 12 and 13 from the north-east, and again on the 24th from due north.

Considering these facts in relation to the spot map showing the case incidence by barrack room and the sudden explosive onset of the disease, there seems little doubt that the epidemic was due to wind-borne refuse dust.

The position of barrack rooms according to companies relative to the dusty area also explains the predominance of cases by companies.

Steps were taken to have this area dealt with, refuse being collected and incinerated a suitable distance from the barrack rooms and the bath boiler no longer fed with dry refuse.

From May 30 to the end of June, the month following the epidemic, there were only six cases of tonsillitis in this battalion, which compares favourably with the total of six cases in the other battalion in Moascar during May, the month of the epidemic.

The numbers steadily decreased from that time to the end of August and there was no recrudescence of the epidemic.

The accompanying table shows the occurrence of cases by dates of admission and by dates of onset of symptoms. The spot maps show the occurrence by companies and rooms in relation to the probable source of infection, and the chart shows the remarkable explosive character of the epidemic; the solid black line indicates the combined figures of cases treated in hospital and in barracks, shown by dates of onset of symptoms.

BACTERIOLOGICAL :—

Twenty-seven cases were swabbed before treatment was started; of these, 9 showed spirilla and fusiform bacilli in association with large numbers of other organisms; the remaining 18 showed no predominant organism. In no case were Klebs-Loeffler bacilli seen. Of twenty-seven cultures on Loeffler's serum slopes no other organisms than staphylococci were obtained.

CLINICAL ASPECTS :—

(1) *Onset.*—About fifty per cent started with sore throats and fifty per cent started with headache and malaise, i.e., in half the constitutional and in the others the local symptoms were the more prominent.

(2) *Symptoms and Signs.*—Practically all had enlarged tonsils with

typical follicular plugs of pus or exudate; about ten per cent had sloughy white or grey punched-out ulcers. The temperatures averaged 102° to 103° F. and a few reached 104° F.

Those in which the throat swab showed spirilla or an unduly prolific fauna of organisms proved the worst cases clinically.

(3) *Complications.*—Quinsy, 10 cases (5·6 per cent). Adenitis, about 12 per cent slight adenitis; 2 cases chronic adenitis; none suppurated. Joint pains or rheumatism, none. Herpes, 9 cases (5 per cent). Respiratory, none. Relapses, two after hospital treatment (1·7 per cent); and two after barrack treatment (3·1 per cent).

(4) *Length of Time in Hospital.*

3 days	1	Mild case, had been orderly in attendance
5 ,, ...	5	2 of these were relapses
6 ,, ...	16	—
7 ,, ...	34	—
8 ,, ...	21	—
9 ,, ...	7	—
10 ,, ...	7	1 case herpes
11 ,, ...	8	1 adenitis, 3 quinsy
12 ,, ...	3	1 ,, 1
13 ,, ...	1	Adenitis
14 ,, ...	1	,,
15 ,, ...	3	2 quinsy, 1 hypertrophy
16 ,, ...	1	Adenitis
17 ,, ...	1	Quinsy
19 ,, ...	1	,,
20 ,, ...	2	,,
Over 20 days	1	Hypertrophy of tonsils

I am indebted to Lieutenant-Colonel L. M. Purser, D.S.O., Commanding Military Hospital, Moascar, for permission to publish these notes.

A CASE OF CEREBRAL MALARIA.

By Major E. V. RUSSELL, M.C.
Royal Army Medical Corps.

Lance-Serjeant F. J. W., Royal Artillery, was admitted to hospital on November 30, 1926, in a collapsed condition. He had been ill for four days, with slight abdominal pain and a little vomiting. He had no temperature and suddenly collapsed in his bed on the morning of admission. He was semi-conscious, jaundiced and slightly cyanosed. The heart sounds were very feeble and sibili were heard over both lungs. The abdominal movement was good and there was no distension. There was no œdema of legs but he had incontinence of urine and fæces. One cubic centimetre of camphor in oil was given. Hot-water bottles were applied and a rectal saline, which was not retained, given. He was seen by the surgical specialist with a view to the possibility of an acute abdominal condition, and a blood-film was taken for malaria.

At 10 a.m. the pulse was absent at the wrist and pituitrin one cubic centimetre and digitalin $\frac{1}{100}$ grain were given.

Malignant tertian parasites in large numbers were found in the blood, and a pint of saline was given intravenously. The patient had a rigor almost immediately after. The temperature rose to 102° F.; pulse 120 and very feeble. Brandy was given with difficulty by the mouth. He died about four and a half hours after admission.

Post-mortem Examination.—A fairly well nourished man. Abdomen: Liver slightly enlarged and olive-coloured. Spleen: About twice normal size, dark-coloured and friable; on section almost black and the blood was tarry; no other abnormalities found. Lungs: Bases of both lungs showed a little congestion; right lung was adherent to pleura at base, probably due to an old attack of pleurisy. Heart: Muscle fibres appeared paler than usual; nothing abnormal found. Brain: Vessels engorged; cortex dull and grey-looking; blood smears from brain capillaries showed many malignant tertian parasites. Spleen: Malignant tertian parasites in enormous numbers.

Echoes of the Past.

AN ARMY SURGEON'S EXPERIENCES IN SOUTH AFRICA, 1843-46.

EDITED, AND WITH A FOREWORD, BY H. B. NEWHAM, C.M.G., M.D.
Late Temporary Lieutenant-Colonel, Royal Army Medical Corps.

(*Continued from p.* 150.)

Fort Peddie, Caffraria,
Southern Africa,
April 2nd, 1844.

George Cowley Esq., Winslow, Bucks, England.

MY DEAR COWLEY,

Although I have written long letters to both you and the Governor, about three weeks ago, which I entrusted to the care of Captain Kennedy, son of the Colonel of the 7th Dragoon Guards, who is on his way home from his regiment stationed in China, yet as he may not find a vessel to his mind I determined to let you know how I go on as the Post-Office takes the opportunity of the first vessel going home. There are no regular mails from England but they forward them as they can. I received two letters from you, the last dated 4th December, and three "Eras." I am glad to hear that you are all well and that his worship the Coroner has recovered his upset.

This is one of the best outposts in Africa and there is very little to do as I have but another post to visit about ten miles off, a very great change from my last station which I have described to you before. This is the

only post over the boundary, the Great Fish River, but is retained by the Government on account of its being the great thoroughfare from the Colony into Caffirland. It is ten miles over the river and eighteen from the coast. It is about a hundred miles north of Algoa Bay, which you may see marked in all the maps.

Our new Governor, Sir P. Maitland, has just arrived, and the late one, Sir George Napier, goes home with the consent of all. We daily expect the reserve battalion of the 45th Regiment, and when they arrive I think it is probable that they will relieve us on the Frontier and that we will be brought up to Cape Town to be ready for embarkation home, as our time is up in the Colony next year. I shall be truly happy to see England again, although this country is interesting for a little.

The 7th Dragoon Guards have great sport at Fort Beaufort, hunting Jackals, Racing, etc. When stationed with them we liked them very much and were great friends. Our Headquarters is now Grahamstown, fifty miles hence. There are none of my regiment here except a Major (Goodman), but we expect a company of ours here in a few days.

I have been lately ill with Rheumatic Fever, from imprudent exposure to the cold night air in pursuit of a Hyena which had the temerity to come into my park during the night. I have been shooting Hippopotami lately, they are an enormous animal and very difficult to kill, their skin being thick enough to resist a leaden bullet. We therefore use one of pewter and lead mixed. It is all snap shooting, and that is when they put their noses to breathe. I was nearly bitten by Ring Calse (Dutch) a most venomous snake. He attempted to strike me when or horseback, but I was too fast for him and hit him with a hunting whip which caused him to retreat into his hole very quickly, from which I could not get him. I saw an Ostrich a few days ago; they are a magnificent creature when going at a full pace which no horse can come near. They are very seldom seen about here now, being so much hunted by everyone.

. . . .

This autumn weather is very hot, 90-100 and in some places along the Fish River, where the soil is sandy, 120 in the sun, but we have always a cool breeze from the sea in the evening. This has been the best crop year ever known as we have constant thunderstorms, and rain such as you never see in Europe.

I am getting on with the Caffir language so as to speak to them and understand them. I am a great man with them, having cured several. They have been quieter lately but seem to delight in forays into the Colony to carry off cattle and fighting against one another; I mean the tribes.

Tell Mrs. Cowley that I attribute the favour I stand in with our ladies to her kind wishes when commencing my career as a soldier. My greatest allies are Mrs. Dr. Delmege, who is the daughter of a great merchant at Cape Town, and an Italian by birth. She is an exquisite musician on both Harp and Piano, indeed, I think I have never heard her equal on those

instruments, and also besides an excellent and amiable woman. Then comes Mrs. Maclean, lady to MacLean, Captain of our light company, and the finest fellow you can fancy. He and I are sworn friends. Mrs. M. is a tall, elegant woman, very handsome, and the best horsewoman in the country. All our ladies have the same sisterly feeling as their husbands and we are acknowledged to be the most united corps in the service, so, as you see, we get on agreeably enough. I have always a line from two or three of them every post-day, once a week. Then on this post we have Mrs. Captain Ward, 91st Regiment, who is quite a treasure, sings ballads in almost every European language, plays the guitar, dances, beats the castanets, is an authoress of some name in the book of Beauty, Forget-me-nots, etc., etc., and rides like an Arab.

If the Governor has not received my letter, please tell him how gratified I was to see the presentation of the plate to him. Truly my good friends at Winslow can do *things*, and when they do them they do them well. What a proud testimonial it will be for you all to look at in future days. I am almost as much gratified as if it were my own, or that of a near relative, as I shall always look upon the Governor as a kind of parent.

. . . .

My allowances, which I think I mentioned to you before, are rations of meat and bread, quarters, fire and light, forage for two chargers, barrel and bulk allowance ; this is for wear and tear of luggage by transport, and a mounted Dragoon when on Duty. The provisions are cheap, and the wine (European) half the price it is in England, best Cape wine from 8d. to 1s. a bottle, so that we can live well and cheaply. I drink very little and smoke also but little. You see I do not forget anything although I have travelled some miles from home. I think the latter part of next year will find us on our way home, then hurrah ! for merry England.

I depend upon your writing and sending me papers as it will serve to keep me alive, particularly a county paper. You must see that I am in great vigour and spirits from the tone of this rambling epistle, but the truth is, a letter I had written last night got so blotted with ink that I could not send it. This is therefore done to save a week's post. I know you will remember me to all your family, and tell the Governor I expect to hear from him and am pleased at your account of the Garden improvements. I am determined to let him taste some of our Cape wine off the Salver, and look forward to the time I shall see him again, I hope, stout and well. He will see some change in me externally, but my mind, my spirit, and my remembrances are the same, although we do live in camp and the wilds occasionally.

Believe me,

Ever most sincerely and faithfully yours,

(Sgd.) W. N. Irwin.

P.S.—All quiet at Natal, but a detachment of ours (200 men) under Major Smith still remains, but we expect them soon. My namesake is

with them, by all accounts he is a splendid fellow and very handsome. Direct to me as before, Cape of Good Hope. I expect a large budget of news by Adam Baynes and hope to see him, but I think it probable that he will be sent to Natal after he has been at Cape Town for a little, and everyone says it is a beautiful and rich country. He will be able to indulge in his love for horses, but if he has not started pray tell him not to buy any directly on landing as he is sure to get a bad one. I think one of the bucking horses will astonish him if ever he sees it for the first time, much less attempt to sit them.

Fort Peddie,
Caffraria,
April, 30th, 1845.

To George Cowley, Esq., Winslow, Bucks, England.

My Dear George,

I have been daily expecting a letter from you. . . . I received the historical register for which I am much obliged. We are, I fear, on the threshold of a fearful and destructive war with the Boers of the interior, They have attacked our firm allies the Griquas, a mixed race of Hottentots, Caffirs, and Bechuanas, fast advancing in civilisation and residing on the Northern bank of the Orange River, and also the Bastards, a race between the Boers and Hottentots who are also located there and under the protection of British Government. By the last accounts from Colesberg (300 miles off) seventeen Boers have been killed and several wounded, ten of the others killed and the Boers had about 4,000 men under arms and were giving no quarter, so you may fancy what will be the result in retaliation. The 7th Dragoon Guards were ordered up to the scene of action and have arrived about to-day with a battery of artillery. We expect also to be moved up, and I am just now like a greyhound in the slips waiting for the route to join the headquarters. We were, before this broke out, under orders for Cape Town and expected to get to England almost immediately, but alas! for human purposes.

I am quite ready to go and see some of the fun and all our fellows seem in the same state, as we have not had an opportunity of meeting the Boers since the butchery of our fine fellows at Natal. However, I think if we are to meet them the work will be sharp and decisive. You are, I think, aware that they are nearly all well and splendidly mounted as regards the training of their horses. The Boer, if necessary, drops down off his horse and kneels or sits upon the ground while he discharges his long gun (Roer?), their aim is unerring and they will pick any individual out at twice the distance of our common musket, but the 7th Dragoon Guards are provided with a splendid Napier rifle and are well mounted, so that they will be able to cope with them.

The Caffirs are now quiet, but how long they may remain so is exceedingly uncertain. I still ride out among them unarmed, but I have a nag I can depend upon to ride a fellow down and set pursuit at defiance. I met

a Caffir a few days ago who seemed inclined to hinder me passing him on a narrow road, when I rode full split at him and gave him as complete a somersault as you ever saw a clown make at a fair. He immediately was on his legs again, but I fancy his gun was not charged as he made no attempt to fire at me, and I did not give him a chance to draw a spear from his bundle as I was away in a moment.

I have a very large collection of curiosities and have a pair of the most beautiful birds in Africa (Amabens) which are even here very rare; I do not think they are to be found in the Zoological Gardens in England. I have made them very tame and they will now come when called and pick out of the hand. They are about three feet six inches in height, which will make it difficult to have them safely conveyed home. I cannot attempt to give you an idea of their appearance.

I hope all friends are well. You must not remain so long without writing to me as I am always on the look-out on post-day. I am just now reading the Stowe festivities in the "Times." What a flare up you must have had? I have no English correspondent except you, that is, a regular one, therefore you must be more frequent. . . .

I never was in better health in my life, but I am heartily tired of idleness and long for the march to Colesberg, where, as I said before, we daily expect to go.

The 7th Dragoon Guards suffered severely during the Summer from Ophthalmia (purulent) and they were kind enough to send me fifteen men with it who are now all well. There are just now none of the men sick under my care. My friend McLean has been ordered to Headquarters which I feel much as he is the prince of good fellows and the hart of Corn (?) not to speak of his elegant and excellent wife who is a very great ally of mine and a regular trump. I have now with me Capt. Wright, 91st Regiment, Ensign White, 91st and Phillpotts, Cape Mounted Rifleman, a son to the Bishop of Exeter and a right good young fellow. Pakenham is the only one of ours with me. I have nothing to do, but if we go up the country to meet the Boers, then comes about six months under canvas with occasional want of water and having to travel under a hot parching sun. Folks at home know little what foreign service is; I am perhaps to-day enjoying myself while to-morrow I shall be marching through an enemy's country and forced to look out so as to have anything to eat or drink, but it is a glorious life nevertheless. The son of the peer has to suffer the same things, and then all the fellows are like brothers and you would little think to hear the songs, etc., in the tents at night that the men perhaps marched 30 miles that morning with no light equipment. Our Colonel encourages the men in all kinds of fun although he is occasionally wrong-headed, but he has the heart of a kind fellow and a gentleman.

You remember my old aphorism from Horace, "Nomo Sine Vitus Nascitur," etc. . . .

The weather during the Summer has been extremely hot, sometimes

above 100 in the shade, but now winter, cool and pleasant, though much like your summer. I amuse myself as usual riding, shooting or reading. This life is certainly a strange one, but I think not altogether unprofitable. I am just now anxiously looking out for the arrival of a fair friend from Ceylon, where she has been with her husband but is returning here as the climate did not agree.

Petre, one of the 7th, had some splendid puppies of the foxhounds they brought out, and when he went away the other day en route to Colesberg he gave me a fine dog. They have good sport and killed a great number of Jackals which are much like a fox but prettier.

You will perhaps ask "am I changed." I answer "No," but the women tell me I am getting florid in the face although I am rather abstemious, yet I can with a friend take my bottle and no hurt.

I am in great force in horseflesh, they are all as sleek as a mouse. I have the best groom in the Regiment, and like his master somewhat of a character, a regular Micky Free. One of my horses is much the stamp of the grey mare but better in the feet. He is a roan and one that can go. I call him "Faugh a Balagh." My best horse I have partly sold to Captain Campbell of the 7th, who will have him for his first charger. He is a sweet creature and has paid me well.

I have a large pipe for Mr. Tomes, B.C., made by a Caffir, and a handsome ebony stick for the Governor. My quarter is more like a furrier's shop than anything else with skins, spears, shields, pipes, shells, etc., etc.

. . . .

Believe me,
Most faithfully yours,
(Sgd.) W. Irwin,
Caffir Wabakaika
or
The Swift.

Fort Brown,
George Cowley, Esqre., Winslow, Bucks. *June 4th*, 1845.

My Dear George,

It is long since I have had the pleasure of hearing from you. Since I last wrote the Boers and our Allies, the Griquas, and Bastards, have been fighting on the other side the Orange River, and the 7th D. Guards were sent down, who charged and utterly routed them with no loss on their part; the 7th now remain in Camp on the Spot, and the Governor and Lieut.-Governor are now there settling matters.

The Governor, it is reported, had a severe fall from his horse and, being a very old man, I fear he will be some time recovering.

I have been at this Post only a few days, and we have been under orders of readiness for Cape Town for the last six weeks prior to going home.

This Garrison is situated on the Great Fish River, 17 miles from Grahamstown, and there is good shooting in the Bush. A Tiger and Buffalo were killed near this a short time since, and I have had the pleasure of hearing a Tiger killing a Baboon. The roars and screams were frightful, although fully a mile off.

I have been in to Headquarters on leave for ten days, and enjoyed myself very much.

Our Colonel, Johnstone, had a party where I enjoyed myself very much. His wife is a nice creature, very clever and most agreeable.

Some of the Grahamstown young ladies are very pretty, but I have not been dangerously smitten.

I am settling down fast into Old Bachelor, my horses taking up most of my attention, and I have now with me a Captain of ours (Wat Butler), formerly famous at home as a Steeple Chaser, and one of the most beautiful horseman I ever saw—a jolly fellow and an agreeable companion. My peculiar friend Maclean is now at Headquarters.

. . . . . .

We have had some most severe weather here, and plenty of snow fell even on the plains around, a thing very unusual.

The Caffirs are very quiet, and there is little robbery going on, not a tenth of what used to be.

We are delighted at the prospect of home, but I think we shall be some months at Cape Town, as our Natal party have to be relieved and join us after being away from the Regt. for nearly four years. . . .

. . . I have, unfortunately, no topics to interest you, as what little of adventure I have had will be reserved for my return, when I shall, I think, be able to give you a pretty good idea of the Scenery, Manners, and Events which are experienced in this Country of vicissitude.

I think I wrote to you telling you I had a handsome brilliant presented to me by a lady, a patient of mine, and had also the other day a most flattering official letter from the head of the department at Cape Town. Connected with my management of some cases of Ophthalmia sent to me from Fort Beaufort, of a very, I may say, Malignant Character, all recovered, without the loss of Sight. . . . I am rather sorry leaving the frontier, the wild scenery and inhabitants affording one objects of thought and the vast solitudes fitting place for Contemplation, away from the jostle of Mankind, and the interruption of Speculation, by its every-day life.

I was, the other morning, while riding before breakfast, surrounded by Wolves, who never, or at least seldom, attack a Man, but they frightened my horse so much that I was nearly killed by rushing through some trees, against whose branches my startled animal brought me violently; and the same day I was nearly in time to see a Tiger killed. He bit some of the dogs frightfully, but was brought down by a rifle when he had the creatures nearly mastered.

How much I wish I had a pair of Mr. Lownde's Bloodhounds here to try them against this desperate beast.

My friend, Fraser, killed a Wild Boar the other day, with his hunting knife, while engaged in the Bush with his dogs, a thing of no slight danger, as their gore is almost certain death. He is becoming a splendid shot, and is now stationed in a right good hunting Country where Buffaloes, Boks, etc., are to be met with.

A young friend has just returned from the interior, where he had a desperate encounter with a Lion single-handed, and after putting in two balls killed him with his knife by stabbing him in the heart, the Animal having sprung upon him; this is, even here a most unusual affair, and reflects credit upon the bravery and courage of the individual. He is, however, a Man of most gigantic proportions, and a Samson in strength.

You will not forget to make my kindest regards to all my old friends, who I trust one day to see.

Write oftener, it is a great pleasure to hear from home, and particularly from you, and do give me all the news, as you know I like to know what is going on.

I sometimes receive your letters while on a *Trek*, and take the opportunity of the first off saddle to stretch myself in the Shade, and, while my orderly sits Smoking or Cooking some Cos (flesh), read your welcome epistle.

Give a kind remembrance to all, and believe me ever,

Yours most faithfully,

W. N. Irwin.

George Cowley, Esqre.

Current Literature.

Health News. New York State Dept. of Health, 1926, v. 3, 9. **Ten Cases of Poliomyelitis in Cortland. First Outbreak definitely traced to Milk.**

This issue of the New York Health Department's weekly Bulletin contains a brief account of ten cases of poliomyelitis which occurred in Cortland in the last quarter of 1925, six of them arising during the third week in December. This is described as "the first outbreak definitely traced to milk." The six cases occurring in December were all found by Dr. A. C. Knapp, health officer, to have consumed milk supplied by the same dealer, in five cases regularly and in one case casually. Further investigations revealed the fact that seven days prior to the onset of the first of the six cases, a boy engaged at the farm, milking the cows and otherwise handling the milk, had been taken ill with what proved to be a typical poliomyelitis, although he continued at work for some four days after the

onset. Prior to this, three cases had been reported, in all of which the date of onset had been given as October 7, but these all took their milk from other sources. Three further cases were reported as developing on December 25. Of these one had consumed the suspected milk, and the mother of another worked in a restaurant where the same milk was consumed. The third, a doubtful case without paralysis, did not consume this milk and had no contact with the other cases.

[The observations are certainly very important as the probability in favour of the milk being the infecting agent is very high, and if the evidence is accepted it gives a very clear measure of the incubation period. In the first six cases the possible limits are between seven and twelve days. If the three further cases are regarded as belonging to the same period the possible maximum is extended to 18 days.]

F. E. WYNNE.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 7.

MCEACHERN, J. **Epidemic Bulbar Poliomyelitis. Report of Six cases with one Necropsy.** *J. Amer. M. Ass.*, 1926, v. 86, 90-92, 3 figs. [4 refs.]

This is an account of six cases of acute anterior poliomyelitis which occurred in Winnipeg during the latter half of August, 1924, in all of which there were symptoms of acute bulbar paralysis with involvement of a limb in only one case. The author quotes MEDIN, PEABODY and WICKMAN in support of the rarity of this condition. In his own series of cases the symptoms suggested that the region of the nucleus of the eleventh cranial nerve was principally involved, but this was not borne out by the post-mortem appearances in the one case in which a necropsy was obtained. Difficulty in swallowing and vocal changes were observed in all the cases and a prominent feature was the presence of frothy mucus in the pharynx and posterior nares. There was also paralysis of the sphincters showing the wide distribution of the lesions from the basal ganglia to the lower portion of the spinal cord. Microscopic examination showed the perivascular infiltration characteristic of these infections of the central nervous system, but a more marked feature was intense and diffuse inflammatory infiltration of the tissues of the pons, medulla and cervical cord. This infiltration was most intense in the spinal cord, illustrating the dissociation between the clinical symptoms and post-mortem findings. In the spinal cord the lateral and posterior horns were principally affected, little change being found in the anterior horns. Nerve cell degeneration and neuronophagia were marked features.

[It is interesting to note that herpes does not appear to have occurred in any of these cases.]

F. E. WYNNE.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 7.

SHAW, E. B.; THELANDER, H. E., and FLEISCHNER, E. C. **Convalescent Serum in Heparalytic Cases of Poliomyelitis: Results of Intramuscular Administration.** *J. Amer. M. Ass.*, 1925, v. 85, 1555-8, 4 figs.

This is an account of five cases of acute anterior poliomyelitis treated by the intramuscular injection of convalescent serum. The cases occurred during an epidemic of the disease, and although the spinal fluid was not examined in three cases, the authors are satisfied that the diagnosis was fully established in every instance. All the cases were severe, and one was fulminating and the child apparently moribund. All recovered completely without paralysis, and the four temperature charts which illustrate the article are certainly most impressive. The dose of the fresh serum given varied from 40 to 92 c.c. The time elapsing between the onset of symptoms and injection of the serum varied from 5 to 22·5 hours. In one case, the worst, citrated blood was used on account of the urgency of the symptoms and serum not being immediately available.

Subdural injections had been employed by NETTER and others in France, and by AMOSS and his colleagues in America following the demonstration by LEVADITI and other workers that immunizing substances were present in the serum of convalescent monkeys and human beings. The intramuscular route was chosen in view of the fact that in its early stages poliomyelitis is a general infection carried by the blood-stream. The ideal would be intravascular administration, but the time lost in the laboratory in the necessary preparation of the serum to render such a procedure safe renders it impracticable. The intramuscular route was accordingly selected as offering the most rapid absorption combined with safety.

[Details of the technique employed in the preparation of the serum are not given and would probably be welcomed by other workers in this field.]

F. E. WYNNE.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 7.

Reviews.

THE MIND IN DISEASE. By M. P. Leahy, B.A., M.B. London: W. Heinemann, 1926. Pp. 178. Price 6s.

The author is a retired brother officer, known to many officers now serving, and the book is a record of cases cured by suggestion.

It is remarkable for being very free from theory, and consists, with the exception of Chapter I, in a record of a series of cases which have been cured by suggestion, very few of the patients attaining true hypnosis.

The author deals very vividly with the chapter, "Conditions I Cured in Myself," explaining the various mental processes and ideas which he conjured up to suggest his probable cure to his own mind and the progress of the cure of his depression and worry, constipation, insomnia, and morphia habit, fear of a vague unreasoning nature and self-consciousness, com-

mencing from the time when he was wounded and captured at Mons in 1914, and as a result lost his right leg.

There is no question, whatever, that a hopeful mental outlook can do much to improve the patient's condition in disease, and any means in our power must be used to that end.

All medical officers—though they may deny it—practise suggestion.

The general practitioner would be a failure who was deprived of it in his armamentarium, and many cases can be cured by suggestion alone, however the dose is administered.

The author does not claim that the mind is omnipotent, nor that suggestion can cure anything, but his book contains a list of over seventy conditions he has cured, and, what is often wanting in such books, details of actual cases cured; and he claims that given average intelligence and a desire to co-operate on the part of the patient, suggestion can help in a vast number of diseased conditions.

The book is recommended for interesting reading and sound common sense. W. L. W.

MONOGRAPHS ON PHYSIOLOGY: CARBOHYDRATE METABOLISM AND INSULIN. By John James Rickard Macleod, F.R.S., M.B., LL.D., D.Sc., Professor of Physiology, University of Toronto, Canada. London: Longmans, Green and Co., Ltd. 1926. Pp. 351. Price 16s.

There is perhaps no more romantic subject in the whole of medicine than that of physiology, and when a particular branch is treated by a master like Professor J. J. R. Macleod, of Toronto, then truly there is a treat in store for the reader. This book, forming one of a uniformly brilliant series of monographs, including those on "The Physiology of Muscular Exercise," "The Secretion of Urine," etc., sets out to discuss the special subject of "Carbohydrate Metabolism and Insulin," a subject round which there has accumulated a mass of literature in every language and in every country in which contributions have been made, so that it is difficult for an investigator to "find himself." The monograph simplifies this, for it reviews in a comprehensive manner the recent advances in the difficult subject of carbohydrate metabolism, and more especially the great additions to our knowledge since the hormone insulin has been isolated. The author, in his preface, mentions this difficulty, and very rightly gives additional weight to the work which has been carried on under his own supervision—work which we know was crowned with brilliant success.

Commencing with a review of the earlier work which went to prove the control of the pancreas over carbohydrate metabolism, the researches and the literature which discuss the part played by the islets of Langerhans are described. It is surprising, perhaps, that over thirty years elapsed between the experiments of Minkowski and von Mering, who produced diabetes in animals by extirpation of the pancreas and the final separation and preparation in commercial form of insulin by Banting, Best, and Macleod. This latter chapter is one of the most fascinating in the book, showing as it does how near to success many workers were, and yet, on account of some

small error of technique, just failed to reach the goal. The clinical histories of depancreatized dogs treated with insulin are minutely described, and prove the part played by insulin and so the islets of Langerhans in the metabolism of carbohydrates. The question of the genesis of sugar from foods other than carbohydrate is dealt with in a clear fashion, and clinically this is of great importance. By ascertaining the D.N. ratio, i.e., the amount of glucose excreted in the urine over a fixed time, as compared with that of nitrogen, we are enabled to trace the source of sugar, and this furnishes the best evidence as to whether the source may be fat as well as protein. The physiologists will revel in the chapters on glycogen, while the clinician will turn to the pages on hyperglycæmia, hypoglycæmia, glycosuria, and the effects of insulin, for guidance on many knotty problems. The monograph concludes with a chapter on the "Pharmacological Assay of Insulin," a subject of great importance, and one upon which international agreement is essential.

THE HYGIENE OF INFANCY. By S. T. Beggs, M.D. London: Bale, Sons and Danielsson, Ltd. 1926. Pp. 62. Price 1s. net.

Dr. Beggs' little volume is written in the form of a questionnaire for welfare centres and for the use of health visitors and school nurses, teachers, social workers and mothers. It embraces them all, is remarkably clear, well-arranged, and up-to-date. Indeed, there is a good deal more in the book than might be gathered from the title, for many of the principles of hygiene involved in this questionnaire on child welfare apply to all ages, and the book should therefore prove useful to those who may be called upon to give popular lectures on health. The last ten pages, which are not in the form of question and answer, contain an A B C of practical health hints; a few short sentences on rheumatism, and how to avoid it; and questions propounded by baby on "What Baby wants to Know." These last pages are spoilt by being intermingled with pages of advertisements—a publishing method which, if intentional, cannot be deprecated too strongly.

AIDS TO MEMORY FOR FIRST-AID STUDENTS AND NURSES. By Vernon Newbon, M.R.C.S. Pp. 53. Price 9d. net.

THE DOCTOR'S BOOKS. By A. P. Bertwistle, M.B., F.R.C.S.Ed. Pp. 22. Price 1s. 6d. net.

These two pamphlets, issued by Messrs. Bale, Sons and Danielsson, are written to meet special demands for literature of this nature. We have not much faith in memorizers, although in our student days they had a great vogue. Apparently they have so still, for Mr. Newton's "Aids to Memory" are of a flagrant and novel character. No doubt they will meet the demands of the class of students to whom he lectures on behalf of the St. John Ambulance Association. Mr. Bertwistle's pamphlet is of a different character; it contains a description, with illustrations of simple and practical methods of bookkeeping, and is intended as a guide to doctors engaged in private practice who keep their own books.

Reports and Analyses.

BRITISH EPHEDRINE.

THIS alkaloid has been prepared from the Chinese drug Ma Huang by the "Wellcome" chemical works. It is issued in tabloid form as Ephedrine Hydrochloride, gr. ½, and has been found to resemble adrenalin in character and action, but has the advantage of more persistent effect, which may be secured equally by oral or hypodermic administration.

Clinical trials show that even when administered by the mouth it causes a rise in blood-pressure, commencing in twenty to thirty minutes and persisting for two hours.

In adrenal insufficiency (Addison's disease) complete relief was obtained in one case by persistent administration of ephedrine. The drug has also been found very useful in the treatment of hay-fever and asthma both in Canada and America.

KURCHI BARK IN AMŒBIC DYSENTERY.

THIS drug has been experimentally tested in the Calcutta School of Tropical Medicine. In 1924, two acute cases were treated with Burroughs Wellcome & Co.'s Tabloid Extract of Kurchi Corticle, the active principle of which is the alkaloid conessine. The drug was rapidly pushed to a full dosage of sixty grains a day by the mouth and was well tolerated. The amœbic infection appeared to be eradicated.

In 1925, the Calcutta School again reported favourably on the drug, which can be used when there are objections to stovarsol and yatren.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notified at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, Clinical and other Notes, and Echoes of the Past.

Any demand for *reprints, additional to the above*, or for excerpts must be forwarded at the time of submission of the article for publication.

Notices of Births, Marriages, and Deaths are inserted in the *Corps News*, free of charge to subscribers. All communications should be written upon one side of the paper only; they should by preference be typewritten; but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed: The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS." War Office, Whitehall, S.W.1.

The Committee has sanctioned the publication of correspondence on matters of interest to the Corps, and of articles of a non-scientific character under a nom-de-plume. These communications must, however, be approved by the Editor before publication.

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CONTENTS.

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Journal

of the

Royal Army Medical Corps.

Original Communications.

DENGUE IN ADEN: A CLINICAL AND STATISTICAL SURVEY, WITH AN APPENDIX ON FEVERS IN ADEN.

By Major G. H. Dive,
Royal Army Medical Corps.

Clinical Study.

Fever.

With a view to indicating the type of fever met in actual practice, I give an analysis of 100 consecutive cases from the 1926 British series, classified according to the temperatures recorded whilst in hospital.

Group I.—"Typical cases" (i.e., those showing the stages of initial fever, remission and terminal fever). Total, forty-one cases. A number of these showed very characteristic saddle-back charts. The initial fever generally fell by lysis, and only in one-third did the temperature reach normal in the interval, and that for a very short period. The terminal fever rose gradually or rapidly, and terminated more frequently by lysis than by crisis. In only four cases was the terminal fever higher than the initial fever. A few cases, notably those ending by lysis, lasted eight or nine days, but the most typical ones ended on the seventh day.

Group II.—"Terminal cases" (i.e., those not showing the stages of initial fever, remission and terminal fever). Total, fifty-nine cases. For descriptive purposes these may be subdivided as below, into four classes, the type mainly depending on the day on which the case came under observation :—

16

Class (*a*).—A short fever ending by lysis and simulating "three-day" fever.

Class (*b*).—An intermediate type—a low continued fever ending by crisis.

Class (*c*).—A longer type, of approximately five days' duration, showing a prolonged lysis.

Class (*d*).—A limited number of cases of step-like rise and fall, lasting about one week, and suggesting a short paratyphoid fever.

Pulse.—With the exception of some acceleration at the onset, the pulse-rate was typically slow throughout the series, not infrequently falling to below sixty per minute.

Blood Changes.—An average of twenty-four consecutive counts gave the following results: Total leucocytes, 4,637 per cubic millimetre; polymorphonuclears, 52·3 per cent; lymphocytes, 40·2 per cent; large mononuclears, 4·5 per cent; eosinophils, 3·0 per cent.

The lowest total leucocyte count was 3,125 per cubic millimetre; polymorphonuclears, 50 per cent; lymphocytes, 47 per cent; large mononuclears, 2 per cent; eosinophils, 1 per cent. The lowest polymorphonuclear percentage recorded was 41, and the highest lymphocyte and large mononuclear, 55·5 and 14 respectively. The fall in the polymorphonuclear total was thus characteristic and general.

Rash.—Owing to the universal existence of extensive and severe sudaminal rashes, it was impossible to state whether the characteristic terminal eruption of dengue was present or not. At the European General Hospital, and amongst Indian troops during this period, I have seen the characteristic rash, and from the confusion between rubella and dengue in the British records for 1922, it is to be surmised that an eruption was a prominent feature in that year.

Adenitis.—Enlargement of the lymphatic glands, particularly the cervical, was quite common and served as a useful adjunct to diagnosis—its presence may have helped the confusion of these cases with rubella.

Urine.—With a view to excluding "seven-day fever" a series of urines was examined for the *Leptospira hebdomidis* with negative results.

Diagnosis.—The diagnosis of these cases depended on:—

(1) Epidemiological factors, including the presence of the vector *Aëdes argenteus.*

(2) Clinical features as outlined above.

(3) Exclusion of other diseases.

In previous years it would seem that in Aden the following diseases have been commonly confounded with dengue:—Influenza, rubella, sandfly fever, malaria and catarrhal conditions of the nasopharynx and bronchi.

Treatment.—The cases were all mild and rarely required more than a

routine diaphoretic mixture. Pains were not often sufficiently severe to call for anodynes.

Cases amongst Indian Troops (1926).—The febrile course of these cases corresponds very closely with that seen in British troops. In May and June rashes of various types were common, and in September I saw some characteristic terminal eruptions. The absence of sweat rashes facilitated observation. Epistaxis was present in a number of the May and June cases and occurred just before the temperature fell—in September it was only observed on one occasion.

Statistical.

With a view to elucidating the position as regards infectious diseases in Aden I compiled composite charts for the years 1922-26 (to end of September) inclusive, showing the incidence of the chief fevers, less malaria, on the one curve.

As regards British troops, it was at once evident that there was each year a definite seasonal rise in April, May, June and July with a maximum in June, the annual curves being almost identical.

This was attributed in successive years to the following causes: 1922, influenza and rubella; 1923, sandfly fever; 1924, dengue; 1925, dengue; 1926, dengue.

So accurate was the correspondence of the curves that I had but little doubt that the annual incidence was due to one and the same cause.

Fortunately I was later able to find a large number of temperature charts, duly labelled with a "diagnosis," for the years in question, and a study of these made it abundantly clear that one disease, and one disease only, was present, viz., dengue.

It may be noted that the officer responsible for the diagnosis in 1922 held a temporary commission and so presumably was meeting the condition without any previous training in tropical medicine. I append a summary of the diagnoses of thirty-four cases of undoubted dengue in 1922 whose temperature charts were available: influenza, 11 cases; rubella, 10 cases; sinusitis and naso-pharyngitis, 6 cases; various diagnoses, 7 cases.

In 1923 when all the cases were attributed to sandfly fever and none to dengue, a study of the temperature charts again shows that they were due in the main, if not entirely, to the latter disease.

Before finding the charts I had established some presumptive evidence in favour of this conclusion by averaging the stay in hospital of cases admitted during the endemic period with the following results: 1923 (eighty-three cases), average time in hospital 9·4 days; 1926 (seventy-three cases), average time in hospital 8·4 days.

Applying the same methods to cases amongst Indian troops, I found much confirmatory evidence and certain new factors. There was the same seasonal incidence in April, May, June and July, attributed in successive years to the following causes: 1922, sandfly fever; 1923, sandfly fever;

1924, sandfly fever and dengue; 1925, sandfly fever and dengue; 1926, dengue.

Compared with the British records it will be seen that in 1922 sandfly fever replaced influenza and rubella, and that in both cases dengue has gradually ousted sandfly fever.

Unfortunately I have been unable to find any charts of Indian cases prior to 1925, but a study of those available shows that many recorded as sandfly fever, pharyngitis and bronchitis, were really cases of dengue.

It is interesting to note in this year, as in 1926, how catarrhal symptoms were prominent in Indian troops, whilst certainly in 1926 this was not the case to any degree in British troops. The diagnosis of influenza and naso-pharyngeal conditions in British troops in 1922 suggests that the reverse was the case in that year.

A special factor is very noticeable in Indian troops, viz., a second febrile wave in the latter months of the year attributed in 1922 to sandfly fever, in 1924 to dengue, and certainly due in 1926 to the latter disease.

The clinical notes on Indian cases already given are from this 1926 series, and it is very striking how largely the September cases were confined to the one company that had been absent from Aden during the normal dengue season (May to July). This company had been free from infectious disease during its absence from Aden, and had only been back a few weeks before dengue had developed in a large proportion of the men.

The same explanation would appear to be valid for 1922 and 1924, an added reason for attributing this second febrile wave in all three years to dengue. The absence of this second wave in 1923 and 1925 is dealt with later.

The factors governing the seasonal incidence of dengue in Aden may be summarized as below :—

British Troops.—Whether the battalion arrives at Aden in December, February, March, or April, the annual epidemic begins in April, reaches a maximum in June and subsides in July. Except for sporadic cases in varying degree in other months the disease is now over until a new battalion arrives. A very high degree of immunity results in respect of those attacked.

Indian Troops.—As with British troops there is an epidemic period, April to July, and, as before, troops exposed during this period appear to be largely immune for the remainder of the same year and considerably so for the ensuing year.

This early wave of incidence is most marked in the alternate years in which the new battalion arrives, the relief taking place in the first quarter.

An additional epidemic period occurs in some years in September (possibly continued into October and November, but here the normal seasonal incidence of malaria may have caused confusion)—it is dependent on the presence during this period of troops who have not been exposed to the disease earlier in the year or in the preceding year.

This second wave appeared in 1922, 1924 and 1926, in the early part of which years the Indian battalion arrived at Aden for the biennial relief —a portion of these units proceeding to outstations would not be subject to infection until their return to Aden later in the year.

In the years 1923 and 1925 when there was no relief there was no second wave, the whole battalion having already been exposed to infection, either in the same or in the preceding year. And in these years the total incidence was much less.

In the case of British troops, where companies are stationed both at Steamer Point and Crater, the incidence is much higher at the latter where there are greater facilities for mosquito breeding. The Indian battalion is stationed at the Crater and mosquito breeding grounds adjoin.

As stated earlier in this section malaria cases were excluded, and as regards figures for British troops this exclusion, except perhaps in 1922, is unimportant. In that year there was a considerable and sharp increase in the malaria incidence in June, the normal maximal period for dengue, and it was evident from the charts examined that some at least of these cases were not malaria but dengue.

Moreover, there was an abnormally high percentage of cases diagnosed malaria without demonstration of the parasite.

It is doubtful if in British troops in Aden proper there is any primary infection with malaria—relapse cases begin to appear with the advent of a new battalion, if this be infected prior to arrival, the maximum numbers occurring in May, June, July and August, without any sudden accession in any one month. With Indian troops the position is quite different. Here, owing to the very high incidence of anopheline mosquitoes in Habil, which is garrisoned by Indian troops, the number of primary infections is relatively high, and the annual malaria wave occurs typically in November, December and January. It would seem possible in some years that the "malaria" wave of April, May and June, dengue being "absent" during this period, was in part at all events wrongly attributed to the former disease.

The very large number of cases diagnosed in these years on clinical grounds (i.e., parasite not found) lends support to this view. This is particularly apparent in 1922 when dengue was "absent" and "malaria" rampant in April, May and June.

It is with regard to sandfly fever, however, that the chief doubts are raised—indeed it is very questionable if this disease has existed in Aden at any period during the years under review (1922-1926). The difficulty—if not the impossibility—of differentiation of sandfly fever from dengue is notorious, but here the one disease (dengue) is certain, the existence of the other (sandfly fever) doubtful and in some cases disproved, whilst the constancy of the seasonal incidence indicates that only one disease is present. This view is supported by the high degree of immunity from second attacks, which would hardly be so apparent were two distinct diseases present.

The seasonal incidence of the disease corresponds with the seasonal incidence of the vector of dengue, this again corresponding with the period of greatest heat and moisture, April to September. There is a slight, but definite improvement in the physical conditions in July and August, when there is also a reduction of mosquitoes and dengue.

No cases have been seen in 1926, either amongst British or Indian troops, which could be diagnosed sandfly fever. Phlebotomus is said to be present in Aden (Crater), but so far I have been unable to obtain specimens for identification, and have had no report of the somewhat characteristic assaults of this insect.

The question is of some importance as regards protective measures. Should sandfly fever be endemic in Aden it is extremely doubtful whether, owing to climatic conditions, the use of sufficiently fine-mesh netting could be tolerated. Even the use of ordinary mosquito netting, as a protection against the vector of dengue is discounted for the same reason.

Summary.

(1) Dengue is endemic in Aden.

(2) For troops arriving in the winter months infection will normally occur from April to July.

(3) For troops absent during this period (and not exposed in the previous year) there is another infective period reaching its height in September.

(4) Both these periods correspond with the optimum season for mosquito development.

(5) A considerable degree of immunity is conferred by one attack.

(6) Various diseases, such as influenza, rubella, sandfly fever, naso-pharyngeal and bronchial catarrh and malaria, have been confounded with dengue.

(7) It is very doubtful if sandfly fever exists in Aden.

I am indebted to Captain J. M. Mitchell, I.M.S., for information concerning Indian cases in 1926 and to Mr. E. Cordeiro, I.M.D., and Mr. T. J. S. Lynch, I.M.D., for much assistance in assembling clinical and statistical data.

APPENDIX.—FEVERS IN ADEN.

The Memoranda on "Medical Diseases in Tropical and Subtropical Areas" (fourth edition) quotes from Smith and Loughnan some notes on undifferentiated fevers of Aden. These are dealt with in the same order and with the following conclusions:—

(1) "A continuous fever lasting fourteen to twenty-one days or longer—common, endemic, and occurring throughout the year." I have not met any instances of this in which it was not possible to diagnose malaria or the enteric group. In any case they were few in number.

(2) "A six to eight-day type of fever, with either a regular fall of temperature or a chart of a saddle-back type. It prevails from May to October, when mosquitoes are abundant." The mosquito in question is the *Aëdes argenteus* and the disease is dengue.

(3) "A low continued fever with few symptoms." These cases, not infrequent in 1926, were invariably associated with polyneuritis which in Aden appears to be a manifestation of beriberi.

(4) The existence of sandfly fever in Aden, at least since 1922, seems doubtful.

(5) Enteric fever and its allies are infrequent.

(6) Malaria has been dealt with previously. The introduction of anopheline mosquitoes into Aden from the immediate hinterland is always possible, and, in view of the large numbers of carriers of malaria commonly present in the station, would be fraught with the gravest consequences.

At present malaria is absent (from Aden proper) except for imported cases. There is no doubt, however, that the climate of Aden will encourage relapse in a large proportion of the men infected prior to arrival in the station.

(7) Dysentery (clinical bacillary exudate) provides a certain number of cases of fever. Shiga infections occur, but the bulk appear on clinical grounds to be Flexner. The local form is particularly fatal to children.

(8) There remain a few cases of fever which it has been found impossible to differentiate. They are invariably short (one to three days' duration), and commonly associated with headache. Some are doubtless due to malaria and dengue. Others appearing after exposure, as on the march or after any sudden accentuation of the normal hot and moist conditions are probably minor manifestations of the effects of heat.

NOTES ON MEDICAL SERVICES IN THE FIELD.

By Lieutenant-Colonel T. S. DUDDING.
Royal Army Medical Corps.

(*Continued from p.* 191.)

Bearer Relay Posts.

The number of these required and their size depends on the distance of the A.D.S. from the R.A.P.'s, the number of casualties expected, their situation in the chain, and the nature of the ground. It may be said that the carry should not normally exceed half a mile, and when the ground is difficult or the casualties numerous the distance should be decreased to 500 to 600 yards, i.e., two to three posts per mile. With a centrally situated A.D.S., the lines of evacuation from the R.A.P.'s will converge, the central one being shorter than the two flank ones (assuming three battalions to be in the front line). If the force is advancing on a definite objective, a central "main artery" will probably have been given in operation orders, relative to which all movements take place. In such a case lines of evacuation will converge to a point on this main artery, which advances with the force; at such a point of convergence would be the bearer officer with his most forward bearer relay post, and a reserve of bearers with him to enable him to establish further posts ahead as occasion demands and the front moves forward. With two stretcher squads working between each R.A.P. and this head relay post, it will be seen that six squads are required there to keep up a continuous clearing; and it is generally stated that each bearer relay post should consist of sixteen to twenty-four bearers with an N.C.O. or senior bearer in charge. Each relay post in rear will require to have at least the same number, and more in proportion if other lines of evacuation converge on the main line.

In trench warfare these posts are usually situated at points of convergance of trenches from different parts of the front, and they become small medical aid posts. At the main one the bearer officer usually makes his headquarters during active operations, and here are collected reserves of stretchers and blankets, and arrangements are made for accommodating lying cases which arrive before the return of the bearers working on the next stage.

Reliefs are normally sent twenty-four-hourly, but during operations twelve-hourly if available. It is to be remembered, too, that the longer the operations the greater the number of lying cases will be. In the first few hours of an attack numbers of casualties are able to make their own way back walking, but as excitement diminishes and fatigue and mental weariness and fasting increase, so does the power of the fighter to withstand shock to

his system decrease. Hence, though the actual number of casualties coming in does not increase, yet the number of bearers has to be increased; this is also necessitated by the exhaustion of the bearers themselves.

When the A.D.S. is on a flank on account of the position of the main road of evacuation, the carry from the R.A.P. on that flank may be direct without the intervention of relay posts, but the carry from the opposite flank may be a long one; in this case the numbers of posts may be great, but their strength will depend on whether they have to serve two or only one R.A.P. Again, although the distance of the front in a direct line from the A.D.S. may be quite short, yet, on account of a stream, or hills, or broken ground or lack of cover, the line of evacuation is often a circuitous and lengthy one. Every advantage should be taken of cover, such as nullah beds, winding though they be; it is very tempting for bearers when they are carrying loads to cut off large bends and go over the top. The bearer relay posts should be situated in nullahs, or advantage should be taken of old trenches, dug-outs, shell holes, etc., definite arrangements for cover being made. Relay posts should be marked with directing flags or in some distinguishing way to indicate their nature, and that aid can be obtained there, even if the bearers are temporarily absent. It is better to have one spare man for duty there and to act as a relief when required

Walking Wounded Collecting Posts.

(It will be noted that the term "post" is now used and not "station," since this is the nomenclature adopted in the new R.A.M.C. Training; earlier writers named the forward ones "posts" and the main rearward ones "stations".) A large percentage of the wounded, especially in the early stages of the battle, are able to make their own way back from the R.A.P. These are the slightly wounded, and if casualties are numerous, they will quickly fill the A.D.S. So it is usual on such occasions to form a walking wounded collecting post for them, its position being notified in Administration Orders, and to it all walking casualties are instructed to proceed direct. A certain number find their way to the A.D.S., where they are redirected. If the A.D.S. itself has to form and find personnel for a W.W.C.P., this should be sited on a separate road and slightly further back than the A.D.S. It may be that one company is detailed to form the A.D.S. and the other a W.W.C.P., the bearers of both companies forming the relay posts; or it may be that the duty of forming the A.D.S. is allotted to another F.A. The main requirements of such a post on a large scale are that it should be in some conspicuous spot so as to be easily found, have good road approaches to enable lorries and buses to clear it, or be so located as to allow of any system of light railways or trolly lines to and from the front area to be made use of; but it should not be in the neighbourhood of dumps of stores. Its organization should be on the lines of other dressing stations. Ample accommodation for reception, dressing, waiting and evacuation are its most important features. This should be

sufficient to enable men to lie down and sleep till attended to or evacuated. A refreshment buffet, on a generous scale, must be supplied. In big battles this may be furnished by the Y.M.C.A., and may be divided up so as to serve men of different divisions in a Corps. Hot tea, sandwiches, biscuits and cigarettes should form the bulk of the provender, and in cold and wet weather warming and drying stoves are essential. Facilities to enable men to cleanse and dry their feet and put on dry socks are much appreciated, and indeed almost necessary when casualties will have to make a train journey before they can be taken into hospital. Sanitary arrangements for a large number of men must receive attention, and latrines and urinals be constructed on a liberal scale.

In the initial *triage* it will be found that a certain number of cases should not have come as walking cases, are seriously wounded, and require treatment as lying cases. They should be separated out and passed to the M.D.S. for treatment, being evacuated in motor ambulances as lying cases. For them a supply of stretchers and blankets must be maintained. The bulk of the casualties are capable of being evacuated as sitting cases in motor lorries or buses, four to twenty of which may be placed at the disposal of the Medical Services by "A" branch for evacuating direct to a C.C.S. Each three-ton lorry can accommodate twenty-five sitting cases. One or two motor ambulances are required for lying cases. A few slight cases can be sent back to the front, and of the sick a certain number to the Divisional or Corps rest station.

When the W.W.C.P. is functioning as a unit independent of the M.D.S., it will be recorded and returns submitted and field medical cards made out (except for lying cases passed on to the M.D.S. of another unit, in which case it will have acted merely as an A.D.S.). In this event it is generally situated further back, in the vicinity but in front of the M.D.S., and it may also establish an advanced collecting post in the forward area in the vicinity of the A.D.S., utilizing massed horsed ambulance transport or sometimes lorries for clearing the worst cases to the main W.W.C.P. In fact, it functions as a field ambulance, forming, as it were, an A.D.S. and M.D.S. for slightly wounded, though they are known by other names.

The clearance of the main W.W.C.P. to the C.C.S. by lorries is preferable to its clearance by train or light railway. Train loads have to be waited for longer, leading to considerable congestion, and for economy in transport a full train load must be first collected. In addition, the C.C.S. finds much more difficulty in dealing with numbers when brought all at the same time in a train than when they come in lorries in a continuously steady flow.

The W.W.C.P. is formed by the unit providing the M.D.S. or A.D.S. when expected casualties are fewer, and the area served is smaller; its situation is then usually further forward than in the former case, and in rear of the A.D.S. A suitable site is the forward car post, where ambulance cars are parked pending their turn to go forward to the A.D.S. as soon as

a full car load comes down. For such a W.W.C.P. the following staff, with necessary equipment, is sufficient: 1 officer, 2 N.C.O.'s, 4 nursing orderlies, 2 clerks and 1 cook. If acting merely as an accessory A.D.S., all casualties will pass through to the M.D.S., to which they will be taken by the horsed ambulances or any auxiliary motor transport supplied. The recording of cases and making returns will then be carried out at the M.D.S., but if evacuating straight to the C.C.S. or to a rest station the recording must then be carried out at the W.W.C.P., and reports sent at regular intervals to the M.D.S. for inclusion in their returns to the A.D.M.S., unless orders have been received for them to be submitted separately direct to him.

Sick Collecting Post.

In association with a W.W.C.P. there is sometimes established what is known as a "Sick Collecting Post," through which pass the majority of the "sick" as opposed to the wounded. It is run quite separately from the former, and has its definite arrangements for reception and evacuation. Such units as the above assume larger proportions and importance and independence of action when operations are continuous and involve the employment in the same area of troops of many divisions or corps, for all of whom the same medical arrangements will serve.

Divisional Collecting Post or Car-loading Post.

Some of the bearer relay posts assume greater importance than others, e.g., those at the convergence of different lines of hand carriage. The above name has been given to such a post when a change from hand carriage to wheeled carriage can be made, whether the nature of the wheeled transport be wheeled stretchers, trollies, trucks, tramways, light railway, light motor ambulances or horsed ambulance. Such transfer will set free numbers of stretcher-bearers, but a certain fixed number are always kept here to act as attendants on the casualties who may have to be temporarily accommodated waiting the making up of a car load or returning transport, and for the purpose of loading up. It is further used as a relief station for the bearers and for the posting of some of the reserve bearers. A small dump of reserve stretchers, blankets and dressings is kept here. The post is also the point at which it may be possible to separate out and direct walking wounded and gassed cases to the dressing stations or posts specially detailed to deal with these cases. It is a sort of advanced walking wounded collection post on the line of evacuation. As before mentioned, it is a suitable spot for the headquarters of the M.O. i/c of the bearers, and with him will be his working and relief staff of one N.C.O. and sixteen to twenty-four bearers. When a break in the trolley line or wheeled system occurs it may be necessary to form a Rear-Divisional Collecting Post.

Reserve Bearer Posts.

In battles of some magnitude and of long duration, it is usual for additional bearers from troops in reserve or from other areas not engaged to be sent forward and placed at the disposal of the Divisional or Corps Medical Services as stretcher-bearers by Divisional or Corps Commanders. When at full strength the three field ambulances of a division can muster fifty-four stretcher squads, but in actual practice these numbers are rarely available for service under the M.O. i/c bearers, except when reinforced by bearers from other field ambulances not engaged, or from troops. In the latter case some 200 to 600 men or more under platoon commanders or company officers may be detailed, and for them large numbers of additional stretchers are required. They are generally sited one half at the A.D.S., forming a rear reserve bearer post, and assisting with the loading and unloading of ambulances, wheeled stretchers, etc., and the other half at the divisional collecting or car-loading post, forming an advanced reserve bearer post, until they are required as reliefs or additions to forward bearers.

Rest Stations.

It is most important for the maintenance of the fighting strength that sick or slight casualties should not be evacuated further back than is necessary, and to carry this into effect arrangements are usually made in each divisional or corps area for one or more medical units to be detailed to open in the back divisional or corps area, to receive such slight cases from the field ambulances, and even convalescent cases from the C.C.S.'s, which are likely to be able to return fit to their units in ten to fourteen days, depending on the nature of the operations. In laying out such a unit, the O.C. can afford to make things more elaborate and comfortable for the patients, as he is more or less permanently fixed. If for a division, accommodation for 300 cases should be made available; and if for a corps, for 1,000 cases upwards. Such a large unit would generally be under canvas. It would be formed by a company or a whole field ambulance, according to its size, and would be organized on the lines of a Convalescent Depot with its dining and recreation rooms, ablution rooms, baths, etc. Special sections may deal with special types of cases, e.g., scabies, or be appointed for special classes such as officers, employed civilians, prisoner of war, etc.

Field ambulances do not as a rule retain their cases more than three or four days, and if a man is likely to recover within that period and there is no immediate likelihood of a move, or of receiving numerous casualties, and if adequate treatment can be given, such a case is kept in the field ambulance. Ordinary cases of mild sickness or disability are transferred to the rest station instead of the C.C.S. When once a case has gone rearwards past the C.C.S. he is counted as lost to the division, corps or even Army (except when an advanced convalescent depot exists for the use of the C.C.S.'s, when it is really acting as a more permanent corps or army rest station).

DIVISIONAL MOTOR AMBULANCE CONVOY.

Under ordinary circumstances, when a field ambulance forms both an A.D.S. and a M.D.S., the transportation of casualties from the former to the latter is carried out by the unit motor ambulances directed from the headquarters of the unit at the M.D.S., where or near which they remain parked whilst awaiting calls to the A.D.S. Two are placed on duty at the A.D.S. for a period of twenty-four hours, and working backwards and forwards carry out the normal requirements. It is only when the numbers of casualties become excessive that the other resting ones are called on, though they may be required for special duties, as, for example, the removal of infectious cases to special hospitals. If the casualties are likely to prove very numerous, then the cars of one or both of the other two field ambulances are placed at the disposal of the O.C., M.D.S., or the cars are massed together to form a divisional ambulance convoy and an officer is detailed to take charge of the whole of the evacuation. This charge may also include that of auxiliary lorry or bus transport used for walking wounded. When such amalgamation occurs, the M.D.S. car park is too small to accommodate the increased number of vehicles, so a park is arranged for on or close to the main road of evacuation from the A.D.S., at a convenient spot for sendiug out relief cars. If the distance between the two dressing stations is on the long side, it is generally desirable to form two parks. (1) A rear one near the M.D.S., used as a main depot where drivers can be relieved, petrol, tyre and oil stores maintained and minor repairs done to the cars; in fact, when the cars are all working at full pressure, it is well to ask the M.T. unit which is responsible for the upkeep of the cars to supply a small workshop unit for attending to these minor repairs if such aid is not available close at hand; the stocking beforehand of a sufficient supply of petrol is of particular importance, and a careful watch must be kept on its consumption and replacement to see that it does not run out; there is nothing more annoying than to have cars stranded from a shortage of petrol; and (2) a forward one situated usually at or near a point where two or more lines of evacuation controlled by the officer in charge D.Amb.C. converge. As this forward park is more likely to be subject to shell fire, more cars and petrol than necessary should not be retained here. If the system is adopted at both parks of checking every loaded car as it comes past and immediately sending forward another to replace it, then both forward park, A.D.S.'s and advance W.W.C.P.'s can be furnished with a continuous supply without delay.

In connexion with the equipment of cars, the importance in cold weather and in long runs of keeping the interiors warm by means of exhaust heaters, by a sufficiency of blankets, and by the exclusion of draughts by properly closing the front and rear openings, cannot be over-estimated when transporting severely wounded or shocked cases. A wagon orderly, to see that blankets do not get blown off the patients (and lost) and to give

notice to the driver of rear conditions, is necessary, and more than once comment has been made when car loads of patients have been despatched without orderlies. In hot countries on dusty roads, the proper closing of the rear curtain to prevent the drawing in of clouds of dust, and the provision of sufficient openings in front to admit air to keep the interior cool are problems which need attention.

Certain classes of cases, such as G.S.W. head or abdomen, which need immediate operation, are generally passed direct to the C.C.S. without unloading from the field ambulance cars. Such cars must call at the M.D.S. first to register the casualties in the A. and D. book before taking them on to the C.C.S. Returning ambulance cars are the means available for taking extra supplies of blankets, stretchers, dressings, etc., to the forward area, and drivers must be very careful to see that the numbers of these articles kept in each vehicle's charge are always replaced when taken into the M.D.S. or C.C.S.

Motor Ambulance Convoy.

This unit, better known as the M.A.C., had its first beginnings during the Battle of the Aisne, though endeavours had been made previously by the medical authorities, but without success, to have motor ambulances provided for the Expeditionary Force. The Headquarters Staff were then, as now, very averse to any increase in transport, and considered that their use would cause too great road congestion and even blockage. However, from their first employment their value was never doubted, and their general adoption followed as a matter of course as soon as they could be supplied. They have provided perhaps the most important asset we possess for the removal in comparative comfort of the wounded soldier in a space of time short enough to allow of the more thorough treatment of his wounds in a hospital remote from the area of active operations, with the beneficial results of the prevention of much suffering, the more rapid healing of wounds, the saving of life and the more speedy return of greater numbers to the fighting line. And further, from the combatant's point of view they have prevented that congestion in the front area brought about by collections of wounded there. The M.A.C.'s are controlled by the army and are usually provided to the number of one per corps with one reserve per army. The actual movements within the corps are controlled by the corps. Their main function is to evacuate casualties from the M.D.S. to the C.C.S., and from the C.C.S. to train sidings or canal wharves on their way to L. of C. units, and for any specific transportation of wounded in the army area behind the M.D.S., though in times of stress they may be detailed to give assistance in front of the M.D.S.

Each M.A.C. has seventy-five cars divided into three sections of twenty-five cars, together with the necessary attendant vehicles for the transport of personnel, stores and workshop, the whole being under the command of an R.A.M.C. major. The personnel consists of an R.A.M.C. wing of 1 commanding officer and 25 other ranks, and an M.T., R.A.S.C. wing of 3

officers and 153 other ranks. Their headquarters are situated in the corps area convenient for access to the C.C.S.'s and M.D.S.'s which they are serving. In ordinary times arrangements are made for the clearance of the latter at definite hours each day, a motor cycle dispatch rider going round beforehand to each unit to ascertain the numbers of lying and sitting to be cleared, so as to enable the requisite number of vehicles to be sent up. But in times of stress the service is continuous, and each vehicle is dispatched as soon as loaded without waiting for the convoy. Definite road circuits may be allotted by corps or army headquarters staff, and these must be strictly adhered to though they may mean a circuitous journey. It may further happen that in control of the traffic the roads are allotted to ambulance vehicles during certain hours of the day only, e.g., they may be allotted to supply vehicles from 6 a.m. to midday, and may be open for ambulance vehicles only from midday to 6 a.m. the following morning.

In order to keep the vehicles in good running order, they are each taken off the road after a certain number of hours running for examination and adjustment; this also enables the drivers to get a short rest. An important duty of the returning ambulances is to see that they take back the same number of blankets and stretchers from a unit as they brought to it, and when required to convey additional ones from the dump maintained at the C.C.S.

In heavy engagements, additional sections of units from other areas may be brought up, and motor lorries, buses or charabancs, supplied by "Q" Branch of the corps or army, placed at the disposal of the O.C., M.A.C. for clearing the light casualties and sick from W.W.C.P., etc.

The reserve M.A.C. is kept by D.M.S. army near G.H.Q. or at the advanced base, and is used for (*a*) local duties, (*b*) as a battle reserve for pushing forward to any area where needed, (*c*) filling the breach in case of any railway breakdown in evacuating casualties, and (*d*) to supplement the ambulance trains if these are insufficent to relieve the congestion at C.C.S.'s.

On the L. of C. the work of road transportation of sick is officially carried out by auxiliary ambulance car companies of the R.A.S.C. (M.T.), which convey them from ambulance trains to general hospitals, and from hospitals to hospital ships; but at the bases are usually to be found Red Cross Units known as Base M.A.C.'s which may be furnished with women drivers.

To whatever formation attached, a point that must not be lost sight of is the efficient disinfection of a car and its blankets after it has been used for the transport of an infectious case before it is again used. Spraying apparatus is usually available in infectious hospital units, where disinfection should be carried out before the car is allowed to return. In other cases the unit to which the car belongs must see that the work is done with the means at its disposal.

MEDICAL TACTICS.

The simplest method of employing the three field ambulances of a division is that in which each field ambulance is attached to and moves with one of the three brigades, and in which two of the brigades are forward in the line and one is in reserve. With a wide front (three to six miles) each field ambulance will work independently of the others and form its own A.D.S. and M.D.S., and the wounded will be evacuated separately to the C.C.S. Some modification, however, is often introduced so as to prevent the opening up of more medical units than are necessary. The employment of one field ambulance to form an A.D.S. and M.D.S. centrally situated is frequently possible on a narrow front or when there are good lateral communications and when the casualties are not heavy.

If the front is a little wider (say two to four miles) and the lie of the roads suitable for them, two A.D.S.'s may be formed and only one M.D.S. retained. In this case the second field ambulance employed may be called upon to form a W.W.C.P. with its headquarters and to assist No. 1 in forming the M.D.S. When the front is very broad and for any reason the main line of evacuation becomes remote from the flank operation a second line must be opened up. This means the establishment of an additional A.D.S. and generally, though not always, of another M.D.S. A frequent cause of such an arrangement is the presence of a river, canal or wood dividing the front. In the case of two formations operating alongside each other it should often be possible to arrange for casualties from such flank operations to be cleared to the A.D.S. of the adjoining formation, though when possible evacuation of casualties through medical units of their own formation is preferable on the ground of retaining information and control of their own individuals, as touch is often lost when they pass through units of other formations. Whenever possible Field Ambulance No. 3 should at first be kept in reserve in rear of the brigade in reserve for employment should any flank movement demand it, or to move quickly forward in case of speedy advance, or to send bearers, nursing personnel, or ambulance transport to the other two field ambulances in times of stress. Combining the ambulance transport, and employing the bearers of all three units under one control are perhaps the commonest modifications made. But if the casualties are likely to be very heavy, the employment of all three field ambulances from the first may be necessary, in which case it may be decided to utilize a whole unit for the formation of each of the two A.D.S.'s, and to employ the third in forming the M.D.S. and W.W.C.P. When a complete F.A. forms an A.D.S. the O.C. makes his headquarters there, but frequently a rear headquarters is formed under the second in command just in rear of the brigade in reserve. To it all unnecessary transport and stores are sent and it also forms a sick post for troops in the reserve area and deals with casualties from medium artillery who are in position in the vicinity. The employment in the forward line of two field ambulances only of a division enables the third one to be utilized for one of

the numerous special employments to which this unit can be put in the rear divisional area, e.g., the formation of a rest station. When the units of more than one division are working together over the same ground, and the same dressing stations are suitable for them all, the control of the medical units is then generally taken over by the corps, and the M.D.S. and W.W.C.P. and rest station at any rate become corps units, while divisions carry out the collection from the front and transportation to the A.D.S. and W.W.C.P. Such control is usually employed in position warfare on a narrow front with fighting continuous over some days, when units of one division are continually being replaced by those of others, and when road communications allow of it.

The Advance.—With two units employed together as one, the system of "leap-frogging" is easily carried out. As the advance progresses No. 2 Field Ambulance, whose bearers are in the line and whose companies are at the A.D.S. alongside of those of No. 1, pushes forward its companies to form a forward A.D.S. before the closure of the first A.D.S. As the forward movement continues No. 1 A.D.S. closes and its companies "leap" through those of No. 2 A.D.S. and establish a third A.D.S. further forward, still close behind the advancing troops, and so on. The headquarters of the two units act similarly, though not so rapidly as regards the advancing of the M.D.S., headquarters No. 2 Field Ambulance going forward and establishing a forward M.D.S. at or close to the site previously occupied by say No. 2 A.D.S.; No. 1 M.D.S. closes as soon as it has cleared its casualties and is ready to come up to and to "leap" through No. 2 M.D.S. and establish No. 3 M.D.S. as soon as the advance has been sufficiently pushed to necessitate this.

The orders for the advancing of an A.D.S. are usually given by the O.C., field ambulance, and are based on his own observations or those of his bearer officer who is in touch with the forward situation. Any such move should be immediately made known to the A.D.M.S. and brigades concerned. But frequently the orders for its move, and almost invariably for that of the M.D.S., come from the A.D.M.S.

The Defensive.—The frontage taken over by a brigade may be reduced to 1,200-1,500 yards. In defensive warfare such a front will be occupied in depth, allowing for outpost, front support and reserve lines or trenches. The R.A.P. may be situated as far back as the last-named line, some 500 to 600 yards behind the front line. The A.D.S. will also be kept some 1,500 to 2,000 yards further back to allow time to move when there is a possibility of the front line falling back. In such case an advanced car-loading post, protected if possible, will be required between the A.D.S. and the R.A.P. Prospective rear sites both for A.D.S. and car posts will also be selected for occupation in case of a withdrawal. The M.D.S. should in these circumstances not be nearer than five miles.

The Offensive.—In the event of a deliberate offensive being undertaken, plans are usually prepared some time beforehand, but preparations are

made as secretly as possible. Medical units and supplies are not moved forward till as late as possible to prevent information being given to the enemy's observers, but there is time for individual reconnaissance of sites, for selection of suitable ones, and for studying maps and air photos of the enemy's area in case of an advance into it. Information may be available as to the sites of enemy R.A.P.'s and dressing stations; these are likely to be suitable and may be used if their positions are known. Much information may be obtained by the A.D.M.S. at the Medical Divisional Conference usually held forty-eight hours before the attack and before the issue of operation orders, which should include such medical information as it is necessary for the troops to know. With the prospects of a formal movement, medical arrangements will include the establishment of lightly-equipped, readily mobile and divisible dressing stations, both advance and main, to allow of the leap-frogging movement being adopted, with reserves to be available for dispatch at once to any position of the front. The collection of wounded in groups along the main road facilitates their removal, and if the sites are well chosen they may progressively become A.D.S.'s and some of them eventually M.D.S.'s. It will thus be seen that an A.D.S. with a collection of wounded in it may be left in the advance with a very small attending personnel to be taken over by an M.D.S. party, thus avoiding much evacuation and traffic of field ambulance motor transport; this is of special help when roads have been made impassable for motor vehicles by shell fire, mines, obstacles, etc., and by bridges blown up. Whenever a W.W.C.P. is to be established under tents, it is very important for work of erection not to be commenced until the attack is launched, as the observation by the enemy of a conspicuous new unit beforehand gives him very valuable information.

Enemy Counter-attack.—When the enemy assumes the initiative and a hostile counter-attack develops, which brings the A.D.S. too near to or in danger of being included in the fighting area, the A.D.S. must be closed as such but retained as a car-loading post or bearer relay post and a new one opened or prepared to open 1,000 yards further back, or in a place suitable to the prepared positions in the rear. If the pressure still continues and develops into a withdrawal the system of backward leap-frogging with two A.D.S.'s must be adopted with a 1,000 yards or mile interval. The advance of the enemy may necessitate the opening of an entirely new line of evacuation, the closing of the old M.D.S. and the establishment of a new one in quite a different area.

The Withdrawal.—It is during withdrawals under enemy pressure that the greatest difficulties in evacuation of casualties are encountered, and it is often impossible to avoid having to leave behind a certain number of stretcher cases through inability to obtain transport to move them from the A.D.S. The main principles are (1) to utilize the vehicles so as to send back the maximum number possible in each vehicle for each journey (sitting cases take up much less room than lying cases) and (2) to

avoid capture of medical personnel and stores. Difficulties are increased by lack of information, absence of orders, interruption of signals, casualties amongst the transport, lack of lorry transport, road blockage, etc. Every effort must be made by divisional headquarters to control the withdrawal and to establish the rearward dressing stations and collecting posts at fixed points, of which information must be given to the forward units evacuating; if the withdrawal is well organized, traffic instructions and road control orders will be issued and strictly enforced. There will be no properly established R.A.P.'s, but collecting posts will be formed towards which all the field ambulance's bearers and wheeled stretchers must be brought up; the horsed ambulances and light motor vehicles must get in touch with them, forming their car-loading posts as far forward as possible, and remove the casualties to the A.D.S. This likewise is a mere collecting post in suitable buildings, so that if wounded have to be left they may be under shelter.

All unnecessary transport and baggage is kept with that of the M.D.S., and is sent back to definite spots in rear to await the further withdrawal of the unit when it is again moved further back. If it is known where the night's bivouac or halt will be the transport and baggage may be sent back there or to a site one or two miles in rear, when a temporary M.D.S. can be formed to deal with the casualties which will be coming in through the night; but advantage should be taken of railway stations for clearing purposes. Doubtless, trains will have been sent forward to assist in the clearance; and evacuation direct to them both from A.D.S. and M.D.S. may be possible without the need of the M.A.C., which will, however, help to clear the M.D.S., as traffic conditions will allow. Walking wounded will be marched back in definite small parties under a senior soldier or N.C.O. casualty to definite collecting posts at railway stations, or road points, where it may be arranged that lorries or buses are available.

The M.D.S., like the A.D.S., is of the simplest type, being arranged so as to provide shelter and temporary attention. Depending on the rate of the withdrawal, a backward leap-frogging will be taking place periodically. Ambulance transport will be controlled by a reliable officer, as much depends on its proper utilization. As before mentioned, all unnecessary baggage is pushed back to a site further in rear at the first opportunity so as not to hamper the collection and removal of casualties, and to get it out of the way. In the absence of orders from the A.D.M.S., which more than likely will be difficult to get through, the field ambulance commander assumes the initiative for moves and for issuing necessary instructions as to disposal of casualties. He is in a much better position to judge the emergencies, just as the A.D.S. commander too is better able to fix the time for vacation of his sites. But it is important to keep all concerned informed of all moves, so that arrangements in the rear for helping on the evacuation may be developed to as great an extent as possible.

Should it be absolutely necessary to leave wounded behind, only the

smallest amount of personnel and material for their treatment must be left to fall into the hand of the enemy. In laying down directions for the conduct of medical units during operations, it must be recognized that whilst the principles remain the same there is no hard-and-fast rule as to the method of employment of the different units or portions thereof. Different A.D.M.S.'s and field ambulance commanders have different ideas, and there are more ways than one of carrying them out effectively. One commander may advance his A.D.S. close to the fighting line, whilst another may carry out the clearance of casualties equally well by placing it further back, and establishing car-loading posts ahead; one A.D.M.S. may provide two M.D.S.'s, whilst another would carry out the work with one, and so on. So long as the plan is well laid, feasible, and carried through in all its details, and is understood by all concerned, it is likely to achieve success. Situations too arise for which a fixed plan cannot well cater, and which must be left for the man on the spot to deal with on his own initiative. Much valuable information regarding the employment of medical units during operations is given in the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS of 1921-22, in articles by Colonels Grattan, Ensor and Hannay, from a perusal of which it will be seen that their individual experiences lead to different methods of employing their units to the same end. It may generally be said though, that the simpler the method and the smaller the amount of intermingling and splitting up of medical units, the easier will be the application of the principles, the fewer the difficulties that cannot be overcome, and the greater the certainty of carrying through the plan to its termination without any contretemps. Too much elaboration at times defeats its own end.

Liaison and Communications.—Field ambulances are officially provided with no means of communication by signal or telephone, and they are dependent on their own motor cyclists, cyclist and duty personnel, or on the chance proximity of a signal post of a unit or formation. The A.D.M.S. has no direct means of his own of keeping in touch with them, and all messages have to be sent through headquarters signals. Experience has shown that considerable disadvantages accrue through this, and numerous are the instances in which units or A.D.S.'s have been captured, or barely escaped capture, or have not sent medical aid when needed through failure of, or delay in, delivery of messages and orders. Signals having no detachment posted with them are frequently unaware of their position. In these circumstances it behoves the medical services to do all they can to help themselves in the matter, and seek for information from all possible sources in order to be able to put themselves in the best position to be of use to the troops.

The A.D.M.S. usually details a motor ambulance car, a motor cyclist and orderlies from a field ambulance for his own use to render himself and the D.A.D.M.S. independent of the divisional arrangements which are rarely sufficient to meet his requirements. His headquarters are often at some

considerable distance from those of other branches of headquarters; "G" branch, who are occupied with the fighting, keep themselves as far as possible from the constant comings and goings which are inevitable, especially with departmental branches. But it is of extreme importance to the medical services that they should be able to get information from, and give information to the other branches for the proper interworking and the making of necessary arrangements, which cannot be done without their assistance. "G" want to know the sites of A.D.S. and M.D.S. and W.W.C.P. for the information of the troops and for the allotment of roads, movement of units and supplies, and in action the number of casualties coming in and their nature, and also the situation as to their evacuation; it is the office which issues intelligence and can give valuable information as to the nature and situation of the fighting and the probable casualties to be expected, and in the case of a possible advance information as to the condition of the roads and the positions occupied by enemy medical units; it controls the issue of maps and field telephones of which it may be possible to spare one for connecting up to A.D.S. and M.D.S.; and it is to "G" that application must be made for the allotment of fighting troops as additional bearers. With "Q" there is much in common, but of especial importance are his powers of allotting accommodation and of arranging for additional transport in the shape of light railways, lorries and buses to evacuate walking casualties and to bring up necessary stores for construction work, etc. "A" can give considerable help with regard to replacement of personnel, disposal of prisoners of war, burials, disposal of effects, return of discharged men to their units, official returns, money requirements, etc. The C.R.E. can give great help in construction and protection work and in repair of roads, etc., especially in the shape of material if units can supply their own labour.

The field ambulance commander, by attending brigade conferences, comes in touch with the brigade headquarters staff and the officers commanding units of the brigade with which he is serving. Much information is gleaned by listening, and many difficulties can be settled and much help given in a few moments conversation. During operations this liaison is maintained through the bearer officer, or officer in charge of collecting duties, so that the earliest possible intimation of operations can be obtained. A whole-time officer can rarely be spared as liaison officer at brigade headquarters, but if one is so employed he must be furnished with means of communicating with his bearer officer and the A.D.S. by telephone, dispatch rider, or messengers. The bearer officer must keep in constant touch with the R.M.O.'s and their R.A.P.'s, and if necessary arrange to bring help to them in times of stress. Field ambulance stretcher squads are attached to the fighting units when necessary and feed and stay with them; and it is the duty of the O.C. field ambulance to replace casualties among R.M.O.'s from his own unit, until replacements can be obtained by the A.D.M.S. Communications with the R.A.P.'s are maintained through the bearer relay posts.

Hill Warfare.—When a force is operating in a hill country, such as the North-West frontier in India, where roads are non-existent, and the transport of the fighting column is wholly pack, when the countryside immediately off the route of advance is hostile, when the lines of communication are only opened at stated times under the protection of armed pickets and an armed convoy, when the force must camp each night in its own armed ring-fence or zareba, and when the Geneva Convention is non-existent, conditions of warfare for all concerned are entirely different from those applicable to fighting in civilized European countries. Such a force has to be dependent on itself alone for periods of days, and be self-supporting in the matter of supplies, as the country of operations rarely can furnish anything to sustain the force. Everything has to be carried on mules or camels ; wheeled transport, much less motor transport, exists in no shape or form beyond rail- or road-head. Along with other units, medical units are put on the "alternative scale" of transport, or in other words ponies, mules, camels, or even at times donkeys, replace the orthodox wheeled transport, and additional man power in the form of extra stretcher-bearers help out the sick-carrying capacity. As the track is generally along the rocky bed of a stream even wheeled stretchers have to be left behind. With such warfare in view the equipment of medical units is made such that it can be loaded without change, either on wheeled or animal transport, and a unit which has started out with wheeled transport may suddenly be ordered to change it to animal transport at a couple of hours' notice. Only those who have experienced both kinds and have had personally to be responsible for the equipment and its loading and safe arrival each evening can appreciate the blessings of wheeled transport and good roads.

In India the system of supply of transport is different from that of the home Army, in that the transport is not permanently attached to the unit with which it is working, but only for the actual hours of the march, since the transport, whether mule, camel or bullock company, returns each evening to its own transport unit. This system has its exceptions, for a certain number of pack mules may be normally retained by a unit which when separated from the transport unit becomes responsible for them. In a field ambulance which is normally altogether equipped with so-called first line transport, when wheeled traffic is supplied, motor ambulances, bullock tongas, and riding ponies for sick, together with a pair or more of water mules, are left permanently with it; when acting with a division, and at any time when liable to be separated from its transport unit, the field ambulance becomes responsible for the whole of its transport which remains with it. But in mountain warfare, when on the move and forming a ring camp each night, all animals go to their own transport unit lines in the rear.

As the force advances from its concentration point at rail- or road-head, it deals with enemy opposition and establishes "strong points" or "staging

posts" along its line of advance at intervals of eight to ten miles, thus forming its line of communication. On the establishment of one such post, an advance is made to form the next by the construction of permanent barbed wire, walled picket posts of commanding points suitable for the protection of the line. Considerable opposition is frequently met in this operation, and numerous casualties may occur amongst the protecting troops. Until each of these picket posts is constructed and occupied, the force does not advance further. And if the opposition is very great and the situation demands it, it may have to withdraw at night to its previous strong point and complete the work the next day. If able to find a suitable camping ground at night at the point reached, it may hold its ground, either retaining its transport or sending it back to the strong point for the night. Sometimes it is necessary to hold the ground reached, though it may be unsuitable for defence, and on such occasions the enemy takes advantage of his opportunity and casualties are likely to be heavy.

The usual disposition of the advancing force is: (1) Strong advanced guard of infantry, 1 battalion or 2 companies, depending on the strength of the force and opposition expected, with some pack artillery and sappers and miners; (2) main body followed closely by the transport at short interval; (3) rearguard.

As regards medical arrangements, each battalion has its usual establishment, but provided with pack transport. The field ambulance or ambulances likewise have only pack transport. For casualties this consists of 40 riding ponies and 12 camels, each of the latter being fitted with 2 kajawahs for lying cases, the camels being in lieu of 8 bullock-drawn ambulance tongas or 4 motor ambulances when wheeled transport is not taken. These are supplemented when necessary by additional bearers attached from the bearer unit, who assist the 20 stretcher squads of the field ambulance.

In order to meet the local situation the A.D.M.S. or senior medical officer of the force is responsible for clearing the casualties from the field ambulances to the first staging post to the rear on the L. of C., and to carry out this he has placed at his disposal: (1) A bearer unit, or company thereof; (2) a half-troop or two to five sections of a camel corps; and (3) additional riding ponies if considered necessary, though usually these are borrowed from the field ambulances. The average Indian foot soldier does not like riding.

The bearer unit consists of 2 officers, 4 W.O.'s (assistant surgeons) and 503 I.O. ranks together with followers. It is a non-divisional unit, and its normal function is the replacement of the M.A.C. by man power under conditions when the use of wheeled vehicles is impossible. Its internal organization is, as far as possible, like that of an Indian regiment of infantry. It is used chiefly to remove lying casualties from the A.D.S. to the M.D.S., and from the M.D.S. to the next post on the L. of C. as well as between staging posts on the L. of C.

The ambulance unit of the camel corps consists of camels specially

selected for their quietness, easy gait, and gentleness in "baithoing" and getting up in loading and unloading. They are each fitted with a pair of camel kajawahs for taking one lying down patient on each side. If only one side is occupied the other must be weighted with baggage or stones to balance. These kajawahs project on each side, so care has to be taken to keep the files of camels with sufficient intervals between them to prevent them bumping their kajawahs against each other, and also to see that when passing along a hillside track there is sufficient clearance for them between the hillside and the camel. Owing to these bumpings the kajawahs become bent and the patient lies in them frequently on an appalling lateral slope, yet I have never known a patient fall from them despite their dangerous look, and the I.O.R. travels in comfort in them, though he appears to be hanging on by the skin of his teeth. He infinitely prefers them to the riding pony which he loathes.

To go with the advanced guard there is usually detailed from the field ambulance a small advanced dressing station party of say five stretcher squads, nursing orderlies, etc., and riding ponies under an assistant or sub-assistant surgeon, which is placed at the disposal of the M.O. i/c. the unit forming the advanced guard; or it may be that a M.O. is sent in charge. If opposition is met a small dressing station is formed, and casualties are collected and sent back by the bearers and ponies to the headquarters of the field ambulance with the main body. The latter sends up reinforcements if required, and if a battle develops the field ambulance sends up a full A.D.S. party and all its bearers to take over from the advanced guard party, and opens a M.D.S. to deal with casualties sent back. If the route to the A.D.S. is well protected, as is often the case when advancing up the stony bed of a river, camels may be sent forward to help in bringing back the casualties and the A.D.M.S. who is usually at force headquarters and alive to all that is going on in the fighting line, details additional bearers from the bearer unit to assist in the clearance of the A.D.S.

As the force is advancing the question arises as to what is to be done with the casualties collected at the M.D.S. The force being on the move the situation is not such that the field ambulance can open up and give full treatment to them, so one of two measures must be adopted: (*a*) If communications are still open with the staging post just left casualties should be sent back to it by means of kajawah camels, bearers of the bearer unit and riding ponies, the medical unit at the staging post assisting by meeting half way and taking them over; (*b*) if the distance advanced is the greater part of the day's march and near the intended new camp, and the rearward line is not open, then application may be made by the A.D.M.S. for an armed escort to send them back the same day, or they may be carried forward to the new camp where the M.D.S. can open up fully and give them adequate treatment and render them fit for evacuation the next day by convoy when the L. of C. is opened.

To return for a moment to the strong point or staging post; in estab-

lishing it the main body, when it advances, leaves behind a sufficient force to hold it and strengthen it against attack until it can be taken over by L. of C. troops following up in close proximity. The troops at the post have not only to hold it, but have to furnish the pickets for the picket-posts and the daily armed convoys to the half-way point both to the staging post in rear and to the main body or staging post next in front. So that a convoy passing down the line from one post above is "taken over" at a half-way meeting point by troops coming up from the post below and bringing with them an up-going convoy, which in its turn is "taken over" by the troops from and returning to the post above. These convoys are accompanied by a small medical detachment consisting of a M.O., assistant or sub-assistant surgeon, three or four stretcher squads, riding ponies and camels, with medical panniers and water mules; this detachment takes charge of the sick convoy and furnishes medical aid to the escorting troops in case of attack. In this way a daily or a half-weekly convoy system is arranged which enables escorting troops to return to the same camp each night, and by this daily convoy casualties are evacuated to the next staging post on the line, bearers and ponies doing only the half journey and returning after handing over to up-coming bearers and ponies from the post below at the half-way meeting point; but kajawah camels go right through and do the full stage, returning empty by the next up convoy on the following day. Notification is sent by signals each night from the upper to the lower post of the number of stretcher squads, camels and ponies required to be sent on the next day to the half-way meeting point.

If there are two field ambulances with the force it is common practice to leave one M.D.S. behind when the main body leaves the front staging post, in order to act first as the force M.D.S. and later to take in casualties sent back from the M.D.S. of the other field ambulance accompanying the force. When on the next day L. of C. troops take over the post from force troops and free the latter to advance and rejoin the main body, one or more L. of C. medical units, known as "staging sections," accompany them and take over from the field ambulance M.D.S., which is thus enabled to rejoin the force. These staging sections are twenty-five bedded units (expansible to fifty) and may be either British or Indian. In mixed forces it is customary to pair them, i.e., one British and one Indian, and this has the advantage of doubling the number of bearers available (twenty-three each) for staging, since both up and down convoys have to be arranged for each day. To supplement these the A.D.M.S. L. of C. may have been given a company or more of the bearer unit, and the bearers of this are posted to the staging sections in numbers proportionate to the evacuating powers of the force. There are also attached a proportion of kajawah camels and riding ponies if arrangements have been made for the daily return of those coming down.

The nearest casualty clearing station is situated at road- or rail-head, or at a main staging post. It will be seen, therefore, that the further the

force advances the more stages will be necessary, and the longer the time taken for a casualty to get to a hospital where he can find rest and full treatment. Knowing this it is therefore very necessary for field ambulances, if they are not on the move, to do as much as they can towards the full treatment of the wounded; and advanced staging stations must be prepared to act if necessary as retention hospitals and carry out more than mere dressing station duties. It is hard for wounds that are crying for rest to be moved on day after day for a whole week, but if the chain of evacuation is not kept up the staging sections will be clogged. It must further be remembered that these units have to take in the sick of the L. of C. troops doing duty at the post, and the sick rate is usually a pretty high one.

Occasionally an independent column goes out from a base carrying supplies for six to seven days and is cut off entirely from it, leaving no lines of communication. Under these circumstances arrangements must be made for additional sick transport, as all casualties must be carried along with the column until it returns to its base, or until it sends in a convoy, in which case a sufficient amount of medical personnel and equipment must accompany them to give them field hospital accommodation and treatment on the return marches.

Rear-guard Actions.—Under normal circumstances the rear-guard is a small one and requires no special medical provision other than what can be readily obtained from the field ambulances with the main body. But in a withdrawal, or with an independent column, conditions are different, as the hill enemy appears suddenly from nowhere and frequently harrasses or attacks the rear-guard of the withdrawing force. In such circumstances the rear-guard is considerably strengthened, and as all casualties must be carried along with it the medical detachment of the field ambulance (or dressing station party) is supplied only with first-aid equipment, and with a large proportion of bearers, ponies and kajawah camels. A particularly difficult operation in which to avoid casualties is the withdrawal of the advanced outlying permanent pickets, as the opportunity for attack is seized upon by the enemy. This withdrawal is usually carried out at night, just before dawn, and a small force is usually sent out to cover the withdrawal. Until all these pickets are in, the rear-guard does not follow the main body, which, however, must act accordingly. The medical assistance that can be given under these circumstances is very small, if any, and if casualties occur, every endeavour must be made by the troops themselves to bring in their wounded comrades. The leaving behind of a wounded man is a condemnation to certain death, as the hillman enemy has no use for wounded. It is remarkable how few wounded and even dead of their own hillmen leave behind; they nearly always, except in the very heaviest fighting, manage to get the wounded away. They are a hardy, active and agile race.

(*To be continued.*)

A CRITICAL REVIEW OF THE PRESENT POSITION OF BACTERIAL AGGLUTINATION.

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(*Continued from p.* 203.)

IV. Agglutination of "Rough" and "Smooth" Types of Colonies and Relationship thereof to Thermo-Stability of Antigens.

At the outset one must state that variation in the characters of colonies of micro-organismal species does occur, but whether such variation can be regarded as an index of variation in the "antigen mosaic" and as evidence of real variation of the species is another matter.

If one could be certain that differences in the agglutination reactions of, for example, smooth and rough variants were due to, or always coincided with, variation in the characters of the colony, we could then accept such colony variation as a fundamental factor in the results obtained.

A serious difficulty is encountered, however, when we attempt to define the term "rough colony," for the question of roughness may be viewed from two standpoints:—

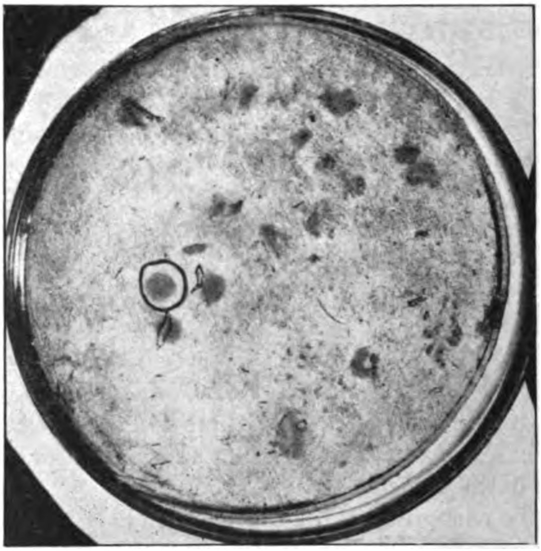
(1) Roughness, irregularity and opacity of colony;
(2) Susceptibility of suspensions made therefrom to flocculate in presence of electrolytes, and in the absence of immune serum.

If a correlation of these two aspects of "roughness" could be established, the discussion would be much simplified, but such correlation does not appear to exist. Thus Arkwright [5], [6] lays stress upon the susceptibility of rough suspensions to flocculation in presence of electrolytes alone. Schutze [1], on the other hand, states categorically that *variation in form of colony and saline stability do not go hand in hand, the variant giving the roughest colony is not necessarily the most saline unstable, and vice versa.* This observation has been verified by the author on several occasions during the course of the present investigation.

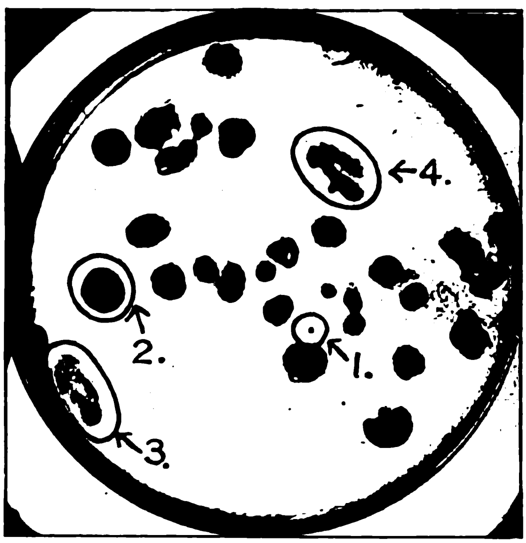
The statement of Schutze can only mean that a rough colony from the standpoint of appearance in culture may be a smooth colony from the standpoint of flocculation in salt solution.

In order, however, to examine this question the following experiment was carried out:—

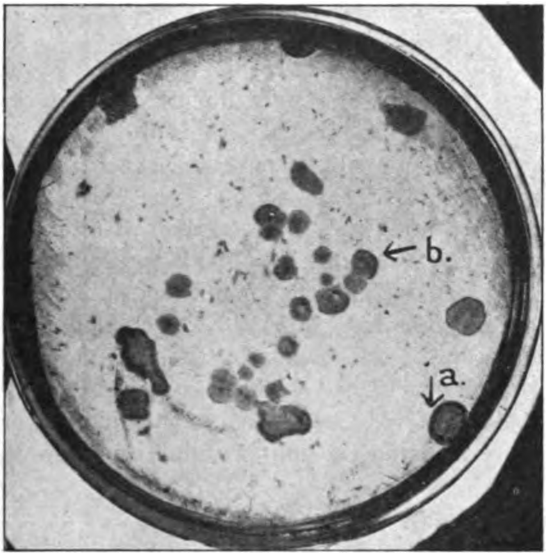
It is claimed by Burnet [21] that cultivation in broth containing one per cent ammonium oxalate leads to the production of rough variants. Cultures of 49 (*aertycke*) and 3,297 (*paratyphoid* beta) were treated thus:—



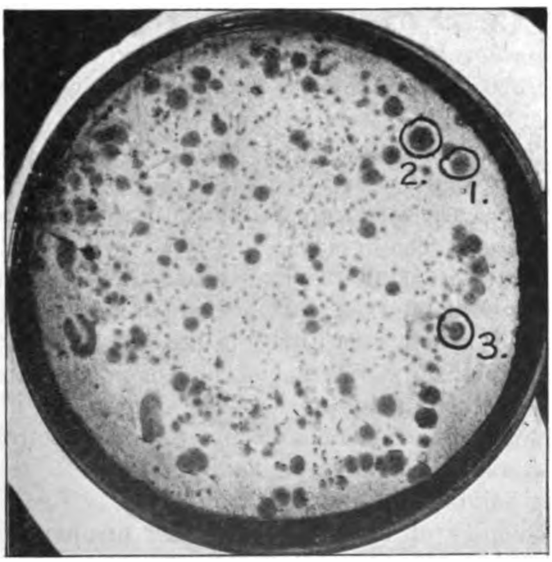
A 49.



B 49.



A 3297.



B 3297.

A. Cultures of both were made in oxalate broth and incubated at 37° C. from February 2 to 23, 1926, when plates were made on MacConkey's neutral red agar.

B. Cultures of both were made in oxalate broth and incubated at 37° C. from February 2 to 12, 1926, being subcultured three times in the same medium during this interval. The fourth subculture was incubated from February 12 to 23, when plates were made on MacConkey's neutral red agar. These plates could not be handled owing to pressure of other work on February 24, and were therefore left at room temperature from February 24 to March 1. The appearance of these plates is shown in the accompanying photographs.

Note.—Owing to an accident plate A49 was spoiled and only one colony is seen in the photograph. It is typical of the remainder of the colonies.

The following observations are to be noted :—

(1) Plate of A49. All the colonies on this plate were "normal" in appearance, i.e., were translucent, non-granular, and smooth in outline.

(2) Plate of B49.

1 is a typical smooth colony.

2 is a variant colony, very opaque, with a dry surface.

3 is a smooth colony which had been used for making a subculture.

4 is a colony which had been used for making a subculture, and which had subsequently developed one side opaque, and the other side translucent.

(3) Plate of A3297. There were thirty colonies on this plate and seventeen of them developed opaque edges, as shown in colonies a and b.

(4) Plate of B3297. The majority of the colonies were small and of the smooth translucent type :—

1 is a large smooth colony at the periphery of the plate.

2 is a typical opaque colony.

3 is a colony with a translucent and presumably smooth centre and an opaque spreading edge.

Four representative colonies from each of these four plates were subcultured for twenty-four hours at 37° C. on agar and were then tested :—

(i.) By rapid rough agglutination with specific and non-specific homologous and heterologous sera, using the same technique as that described in the previous section.

(ii.) By exposure to varying concentrations of electrolytes.

The results obtained are shown in Table XIII.

The following points call for comment:

(1) The colonies of Culture 49 whether opaque and dry (? rough) or transparent and moist (? smooth) do not show any tendency to flocculation by salt solution alone.

(2) So far as rough agglutination is concerned the opaque colonies of Culture 49 on the whole give more specific reactions than do translucent colonies.

(3) Many of the colonies of 3297 show a marked susceptibility to flocculation by salt, and both opaque and translucent colonies may exhibit this to a greater or less degree.

(4) Tested by rapid "slide" agglutination the normal, translucent, moist (? smooth) colonies of 3297 show on the whole greater serological specificity than do the opaque colonies of 3297.

The above findings therefore corroborate the views expressed by Schutze, that the form of the colony does not bear a definite relationship to its susceptibility to flocculation by salt solution, nor does it, at least under the conditions of the above experiment, bear a relationship to specificity of agglutination. It is, of course, possible that these opaque colonies and opaque areas of individual colonies are not really rough but are merely representatives of the so-called O type of colony. The

TABLE XIII.—Agglutinating Serum.

	49 Spec.	49 Ord.	3,297 Spec.	3,297 Ord.	Influence of NaCl solution, 2 hours at 37° C. M.	8/10 M.	6/10 M.	4/10 M.	2/10 M.	1/10 M
49A.										
Colony 1. "Normal."	(+)	++++	–	++++	–	–	–	–	–	–
Colony 2. "Normal."	++	++	–	++++	–	–	–	–	–	–
Colony 3. "Normal."	++++	–+	–	++++	–	–	–	–	–	–
Colony 4. "Normal."	(+)	++++	–	++++	–	–	–	–	–	–
49B										
Colony 1. Opaque.	++++	++++	–	–	–	–	–	–	–	–
Colony 2. "Normal."	–	++++	–	++++	–	–	–	–	–	–
Colony 3. Opaque.	++++	++++	–	–	–	–	–	–	–	–
Colony 4. Normal.	–	++++	–	++++	–	–	–	–	–	–
3297 A.										
Colony 1. Opaque.	–	++++	(+)	++++	++	++	++	++	–	–
Colony 2. Normal.	–	–	++++	++++	++	+	+	+	–	–
Colony 3. Opaque.	–	++++	++	++++	++++	++++	++++	++++	++	–
Colony 4. Normal.	–	(+)	++++	++++	–	–	–	–	–	–
Of one colony { 5. Opaque edge. 6. Normal centre.										
5. Opaque edge.	–	–	++++	++++	++++	++++	+	–	–	–
6. Normal centre.	–	++	++++	++++	++++	++++	++	+	–	–
3297 B.										
Colony 1. Opaque.	+	+	++++	++++	++	++	++	++	++	++
Colony 2. Normal.	–	–	++++	++++	–	–	–	–	–	–
Colony 3. Opaque edge of normal.	–	–	++++	++++	–	–	–	–	–	–
Colony 4. Normal.	–	–	++++	++++	–	–	–	–	–	–

important point, however, is that, whether they be called rough colonies or O colonies, the correlation of the characters of the colonies with serological reactions is by no means complete.

In view of this finding, it seemed of interest to carry out similar tests with suspensions of micro-organisms that had been exposed to varying conditions, and in so doing to contrast specific with group strains.

For this experiment the following suspensions were used:

A 49 specific strain unheated.
B 49 ,, ,, exposed to ammonium oxalate half saturation heated to 55° C. for four hours and then washed with distilled water.
A 49 group strain untreated.
B ,, ,, ,, treated as B.
C 3297 specific strain untreated.
D 3297 ,, ,, treated as B.
C 3297 group strain untreated.
D 3297 ,, ,, treated as B.

The eight suspensions were then divided, each into three portions:

(1) One portion of each was left untreated.
(2) The second portion of each was heated to 65° C. for thirty minutes.
(3) The third portion of each was heated to 95° C. ,, ,, ,,

In order that the suspensions might be added in as small a volume as possible they were then centrifuged, the super-natant fluid decanted, and a

TABLE XIV.

NaCl.	M.	8/10 M.	6/10 M.	4/10 M.	2/10 M.	1/10 M.
	Suspensions not heated (except the oxalated suspensions—vide text.)					
49 Specific ..	—	—	—	—	—	—
49 Specific oxalt.	—	—	—	—	—	—
49 Group ..	—	—	—	—	—	—
49 Group and oxalt.	—	—	—	—	—	—
3297 Specific ..	—	—	—	—	—	—
3297 Specific oxalt.	—	—	—	—	—	—
3297 Group ..	++++ g.	++++ g.	++++ g.	++++ g.	—	—
3297 Group Oxalt.	++++ g.	++++ g.	++++ g.	++++ g.	+ g.	—
	Suspensions heated 65° C. for 30 minutes.					
49 Specific ..	—	—	—	—	—	—
49 Specific oxalt.	—	—	—	—	—	—
49 Group ..	—	—	—	—	—	—
49 Group oxalt...	—	—	—	—	—	—
3297 Specific ..	—	—	—	—	—	—
3297 Specific oxalt.	—	—	—	—	—	—
3297 Group ..	++ s.	++ s.	++++ g.	+	tr.	—
3297 Group oxalt.	++++ g.	++++ g.	++++ g.	+	tr.	—
	Suspensions heated 95° C. for 30 minutes.					
49 Specific ..	++ g.	++ g.	++ g.	+ g.	+ g.	+ g.
49 Specific oxalt.	++ g.	++ g.	++ g.	++ g.	+ g.	+ g.
49 Group ..	+	+	+	—	—	—
49 Group oxalt.	+	+	+	+	—	—
3297 Specific ..	—	—	—	—	—	—
3297 Specific oxalt.	—	—	—	—	—	—
3297 Group ..	—	—	++ g.	++ g.	++++ g.	++++ g.
3297 Group oxalt.	—	—	—	++ g.	++++ g.	++ g.

g = granular precipitation.
s = "sludgy" precipitation.

loopful of the deposited bacilli added to each tube of electrolyte. These micro-organisms so treated were exposed to various concentrations of electrolyte for two hours at 55° C. and the results obtained are noted in Table XIV.

Both the specific and group strains of 49 were derived from transparent colonies, as also was the specific 3297 strain, while the group 3297 strain was derived from an opaque colony.

The experiment tabulated in Table XIV furnishes proof that heating to a temperature of 95° C. markedly alters the susceptibility of micro-organismal suspensions to the precipitating influence of electrolytes, i.e., their physical properties are modified by exposure to such temperatures.

Furthermore, a study of Table XIV shows that one can correlate neither specificity of serological reaction nor character of colony with the alteration in the physical state produced by heating, for:

(1) The specific strain of 49 becomes precipitable by electrolyte alone under the conditions of the third part of the experiment, while the specific strain of 3297 does not.

(2) The group strain of 49 is not in this respect affected to the same extent as is the specific strain. One might almost have expected the reverse.

(3) Exposure of the group strain 3297 to oxalates followed by heating to 95° C., produces a marked "negative phase" in presence of the higher concentrations of electroclyte.

It would be well to note here that most observers are agreed that specificity is not a factor of either roughness or smoothness, i.e., rough or smooth micro-organisms may give specific or group reactions. They may exhibit, then, either the specific or non-specific phases of Andrewes, so that, as emphasized by Andrewes, diphasic variation cannot be correlated with the characters shown by the colony of the strain.

The question of differentiation between smooth and rough is made still more complex by the fact that the terms are applied to organismal suspensions giving flocculent and granular agglutination respectively.

We can, then, regard the terms rough and smooth from three viewpoints:—

(*a*) Characters of colony.

(*b*) Susceptibility to sedimentation by salt in absence of serum.

(*c*) Quality of agglutination produced in presence of immune serum.

It has just been noted that (*a*) and (*b*) cannot be correlated, but it might be possible to correlate (*b*) and (*c*) or (*a*) and (*c*).

When we attempt such correlation of (*b*) with (*c*) we find from experiments already quoted that, in the case of the micro-organisms under consideration, a strain susceptible to sedimentation by salt may well agglutinate in a floccular manner, and the same is true when we compare (*a*) with (*c*). We can, therefore, conclude that the development of

roughness is not necessarily associated with a loss of any particular antigen.

We are left still without a definition of roughness, and in the absence of correlation between the three aspects thereof it is by no means easy to follow the arguments of those who have dealt with this subject.

Notwithstanding this uncertainty there has been a tendency to advance hypotheses concerning antigenic variation, which hypotheses have been based upon observations of the serological behaviour of rough strains. The majority of these observations deal with *in vitro* reactions which, as we have seen from the first two sections of this communication, are inadequate for that purpose. Some of these hypotheses are of far-reaching importance, both practically and academically, and certain of them have been stated in language admitting of but one interpretation, viz., that they are of the nature of generalizations and not without significance in general biology.

Bruce White [16] sums up the relationship of smooth and rough strains of the Salmonella bacilli, thus :—

"(1) The flocculating antigens and agglutinins of smooth and rough strains are identical in quality, but in the rough organism the flocculating elements tend to become reduced or even obliterated. This reduction is associated with an often great reduction of agglutinability to flocculating agglutinins. Organisms which fail to flocculate may still absorb and stimulate flocculating agglutinins when the dosage employed is massive. The rough organisms are liable to exhibit the specific and non-specific phases of Andrewes; but, especially when the flocculating antigens are weakly developed, permanent one-phase races appear to occur. Most of the lastingly one-phase rough races we have studied have been specific.

"(2) The granulating antigens of rough forms present the real serological problem of roughness. In many rough sera the granulating agglutinins are not sufficiently different from those of smooth sera, or are not sufficiently developed, to alter markedly the facies of absorption tests.

"In other cases, particularly where the flocculating factors are markedly reduced, new granulating antigens and agglutinins, absent in the smooth parent strains and sera respectively, come into evidence.

"Apparently the rough organisms *may* possess all the granulating constituents of the smooth parent, but in other cases it is clear that the smooth complex of granulating antigens is only partly represented or even totally absent.

"Briefly, the development of new granulating antigen, peculiar to roughness, tends to be associated with reduction in the quantity and quality of the original antigenic constituents, both flocculating and granulating."

This author thereafter proceeds to compare the behaviour of suspensions of rough variants with boiled suspensions, and concludes that the granulating antigens of rough variants are as thermo-stable as those of the normal smooth forms.

There are several points in this excellent summary that are worthy of note.

The first sentence of the above quotations really involves two concepts and might be interpreted thus:

(A) The flocculating antigen of smooth strains is identical in quality with that of the rough strains. The flocculating elements (antigens) tend to become reduced or even obliterated in the rough strains, i.e., on comparing rough with smooth strains, the rough tend to show granular and the smooth floccular agglutination.

(B) The flocculating agglutinins of sera prepared from smooth and rough strains are identical in quality, but in the sera prepared from rough strains flocculating agglutinins tend to become reduced or even obliterated.

The findings of Bruce White's experiments would appear to bear this out to some extent, but we meet with a difficulty, a difficulty which, although admitted, is not sufficiently stressed, viz., that A and B do not bear a definite relationship to one another. Thus it is noted that "organisms which fail to flocculate may still absorb and stimulate flocculating agglutinins when the dosage is massive," i.e., the so-called flocculating antigen is poorly developed in such rough strains, and may be reduced to "a subagglutinative level." The facts, however, are somewhat more complex than the above statement would imply, for we can by a variety of simple procedures—by exposure to heat, or by simple washing, by exposure to half saturated ammonium oxalate solution, etc.—so affect suspensions of micro-organisms that they no longer exhibit floccular agglutination, but this cannot be interpreted thus—that we have by these procedures deprived the micro-organisms of that antigen which is involved in the process of floccular agglutination. For example, Culture *aetrycke* 49 when first isolated was extremely susceptible to heat, and exposure to 60° C. for thirty minutes so altered it that it agglutinated only in the granular fashion and with fairly concentrated serum (dilution in 800), although the serum used in the particular test was prepared by inoculation of bacilli which had been exposed to 65° C. for thirty-five minutes, and it agglutinated the unheated suspension, giving floccular agglutination in a dilution of 1 in 12800. According, therefore, to A these micro-organisms were deprived of their flocculating antigen, but according to B they were not, and moreover the question of massive doses does not arise. Tables V and VI show a similar apparent contradiction in the case of bacilli, both *aertrycke* and *B. paratyphosus* beta, rendered "rough," according to the method of Burnet [21], by exposure to half saturated ammonium oxalate and heating to 55° C. for four hours.

In this connexion a very interesting observation was made by Orcutt [3] who, however, did not comment upon it. An antiserum was prepared to separated flagella, and was used for agglutinating flagella separated from

the homologous motile strain, the motile strain untreated, i.e., whole bacilli, and the non-motile variant strain of the micro-organism which formed the subject of her study. This anti-flagella serum reacted thus:—

(*a*) With separated flagella its titre was 1/230.
(*b*) With whole motile bacilli its titre was 1/5120.
(*c*) With non-motile variant its titre was 0.

Assuming that the anti-flagella serum reacts specifically with flagella, there is a remarkable discrepancy of titre between (*a*) and (*b*), and one seeks for an explanation of this. It is possible that the method used for their separation has rendered the separated flagella less susceptible to flocculation than the attached flagella, but the very fact that the flagella are attached to bacilli, structures more easily affected by gravity than the flagella themselves, may account for the apparent discrepancy. The flocculation of a "complex" so arranged that it entangles heavy particles will be much more easily demonstrated than that occurring in absence of such particles. It would have been interesting to note how mixtures of the following nature behaved:—

(1) Flagellar suspension plus suspension of "shorn" organisms.
(2) Flagellar suspension plus non-motile variant.
(3) Flagellar suspension plus a bacillus morphologically similar to, but having no serological affinity with, that from which the flagella were obtained.

Whatever the result of such experiments, the interesting fact remains that the separated flagella do not give obvious reaction with an anti-flagellar serum to the same titre as do the whole motile bacilli. This is an example which calls attention to the extreme importance of the physical state of the interacting substances upon the final result obtained in any agglutination test.

The second conclusion of Bruce White is of far-reaching importance and merits careful consideration: "The granulating antigens of rough forms present the real serological problem of roughness. In many rough sera the granulating agglutinins are not sufficiently different from those of smooth sera, or are not sufficiently developed, to alter markedly the facies of absorption tests. In other cases, particularly where the flocculating factors are markedly reduced, new granulating antigens and agglutinins, absent in the smooth parent strains and sera respectively, come into evidence. . . . Briefly, the development of new granulating antigen, peculiar to roughness, tends to be associated with reduction in the quantity and quality of the original antigenic constituents, both flocculating and granulating."

This may be interpreted thus: *That the real problem of roughness is the acquisition by the rough organisms of a new granulating antigen.* That is, the granulating antigen of the smooth type becomes changed into, or is lost and replaced by, a granulating antigen peculiar to the rough type. This *new* antigen is thermo-stable but differs from the thermo-stable

(granulating) antigen of the smooth strain. The evidence upon which this statement is made may be summarized thus :—

A. Using "smooth" sera granulating reactions are obtained with both smooth and rough forms if these have been heated to 100° C. for one and a half hours, but the reaction is more marked with smooth strains.

B. Using "rough" sera granulating reactions are obtained with both smooth and rough forms if these have been heated to 100° C. for one and a half hours, but the reaction is more marked with rough strains.

C. Using "smooth" sera all the granulating agglutinins are not (may not be) removed by absorption with the heat-stable constituent of rough strains.

D. Using "rough" sera the granulating agglutinins are not removed by absorption with the heat-stable constituents of smooth strains.

The view that the heat-stable antigen of rough strains is different from that of smooth strains appears to be confirmed by the work of A. N. Goyle [17]. This investigator, using the absorption of agglutinins test as a method of making receptor analysis, brings forward evidence to show that so far as *B. typhosus* and the Gaertner bacillus are concerned, one may divide these organisms thus :—

(1) Each, whether in the smooth or rough form, has flocculating agglutinins which are specific and thermo-labile.

(2) The thermo-stable factor of the normal (smooth) strains is different from

(3) The thermo-stable factor of the rough strains.

In order to explain all the reactions observed in the tests no less than six kinds of antigen are postulated by this author as occurring in the two organisms :—

(*a*) Thermo-labile and specific for each in both smooth and rough forms.

(*b*) Thermo-stable and specific for each in the normal form, and also in that form which is assumed to be modified by deprivation and which is designated the O form.

(*c*) Thermo-stable and non-specific for both in the normal form and the O form.

(*d*) Thermo-stable and non-specific for both in the rough form.

This seems to permit of but one interpretation, viz., the granulating heat-stable agglutinogens of smooth strains differ from those of the rough strains, and therefore roughness is due to the acquisition of a new thermo-stable granulating antigen.

The acceptance, however, of this obvious interpretation of the facts involves the following assumptions :—

(1) That the term "roughness" can be defined.
(2) That the term "thermo-stability" can also be defined.
(3) That *in vitro* tests constitute a true image of *in vivo* reactions. That is, that the term "antigen" can be so defined as to satisfy both *in vitro* and *in vivo* tests.

Previous sections of this communication show that we cannot justifiably make those assumptions and that the third of them is of very considerable importance in the present instance. Thus Goyle states that difficulty is experienced in making a pure O antiserum, for, although the O type of bacilli in his tests agglutinated only in granular form, on inoculation into animals it produced both granulating *and* flocculating agglutinins. Moreover, absorption of antiserum to the normal type by the O form failed to remove the flocculating agglutinins, and so we encounter the old anomaly, that the O form contains an antigen which is demonstrable by animal experiment, but is not demonstrable by *in vitro* agglutination or absorption tests. Therefore, in the communication quoted it has not been proved by serological *in vitro* tests that the O form does not contain the so-called thermo-stable factor of the rough form. Let us consider how the proof of that concept might be adduced.

I. Expose a rough form to an O serum and an O form to a rough serum. The findings of Goyle show that :—

(*a*) The rough form agglutinates in a floccular fashion with the O serum; thus introducing a complication which renders interpretation of the results very difficult indeed. To overcome this difficulty it is assumed, in order that the facts may be explained, that the O antigen is impure and contains a residue of the flocculating antigen, but no evidence of this impurity is forthcoming when the O form is exposed to an antiserum of the *normal* type.

(*b*) The O form exposed to a rough serum may apparently behave in a variety of ways.

(i) It may fail to agglutinate.
(ii) It may agglutinate in a granular or muddy fashion.
(iii) It may even flocculate.

The last is interesting, for it almost forces the conclusion that the flocculating agglutinins of "anti-rough" serum may be different from those of "anti-normal" serum, as the former may, in the case of *B. typhosus*, agglutinate the O antigen in the floccular form, while the lattter does so only in the granular form; the same suspensions were used throughout the tests, and variants of the same stock cultures were employed to prepare the sera. If these agglutinins are different, presumably the antigens are also different, and therefore it is logical, if we are to accept the receptor analysis method, to postulate still another antigen—a flocculating antigen peculiar to the rough form of the typhoid bacillus—which, on inoculation into animals, will call forth an antibody that reacts *in vitro* with the flocculating antigens of the O form.

II. Absorb a rough antiserum with an O suspension and an O antiserum with a rough suspension.

(*a*) Absorption of rough serum by O suspension leaves the flocculating agglutinins almost intact, but we note that the O suspension contains flocculating antigens for both the rough and normal forms, the former demonstrable in some cases by both *in vitro* and *in vivo* tests, and the latter only by *in vivo* experiments. Unfortunately, the conditions of the tests do not permit, owing to this complicating factor introduced by floccular agglutination, of a clear statement concerning the effect which absorption of rough antiserum with O forms has upon the granulating reactions with rough forms. We cannot, therefore, state categorically that the O form is devoid of the rough granulating antigen.

(*b*) Absorption of anti-O serum by rough suspensions leaves, to a considerable extent at least, the granulating agglutinins for the normal and O forms, but if we consider II (*a*), it is seen that this does not necessarily imply that the rough form is devoid of the granulating antigen of the normal and O forms, for the normal and O forms may contain that antigen undemonstrable by *in vitro* experiment in the same way as the O form contains a flocculating antigen which is undemonstrable by *in vitro* experiment. The position, then, is this, that we do not have unequivocal evidence that the rough granulating antigen is absent from the O form, nor that the O granulating antigen is absent from the rough form.

Only those experiments of Goyle's in which unheated suspensions were used have been so far analysed in the present communication, and it remains now to consider the results which he obtained, employing heated suspensions. Only two of these are quoted *in extenso* in the paper under consideration, and they deal with the relationship that exists between the heat-stable antigens of *B. typhosus* and those of the Gaertner bacillus. They are worthy of note, for it is upon them that the statement is based, that there is a heat-stable non-specific antigen common to the typhoid bacillus and the Gaertner bacillus. The facts are these :—

(1) Absorption of anti-normal typhoid serum by normal unheated Gaertner bacilli or by rough unheated Gaertner bacilli does not remove the flocculating or granulating agglutinins. So that after such absorption the unheated typhoid bacilli are agglutinated in the floccular and the heated bacilli in the granular condition.

(2) This absorption results, however, in the removal of non-specific granulating agglutinins for both unheated and heated suspensions of normal Gaertner bacilli which are present in the antityphoid serum.

(3) But absorption of the anti-normal typhoid serum by heated or unheated *rough* Gaertner bacilli does not remove therefrom granulating agglutinins for *normal* Gaertner bacilli, heated or unheated.

The converse experiment, using an anti-Gaertner serum prepared by inoculation with normal Gaertner bacilli, gives the same result. This is interpreted thus: That the granular heat-stable non-specific antigens

present in the rough form are different from the granulating heat-stable non-specific antigens of the normal form.

Further observations were made but are not tabulated by the author, and the results obtained are interpreted as showing that the thermo-stable fraction of normal or O forms, on inoculation into animals, gives pure anti-serums to the heat-stable O antigen. The findings are summarized thus :—
"All experiments with unheated and heated emulsions (suspensions) of the three forms and their appropriate sera are consistent with the view that the normal N cultures contain two kinds of antigens: heat-labile flocculating and heat-stable granulating, and that the O differs from the N *in containing none of the heat-labile*, but probably a larger share of the heat-stable antigen, while the R form contains heat-labile flocculating antigen and a special heat-stable antigen not found in the N and O forms, but has lost the normal O antigen."

This summary is inaccurate for :

(1) The unheated O form does contain flocculating antigen.

(2) There is for the same reason no evidence that the R heat-stable antigen is absent in the O form.

(3) Again, for the same reason, there is no evidence that the O antigen is absent from the R form.

The whole question is rendered more complicated by the introduction of the experiments which deal with so-called heat-stable antigen, for, as has already been noted, there is no adequate definition of thermo-stability. In this connexion it is to be observed that for reasons already noted one cannot accept results based upon the behaviour of heated suspensions as evidence of similarity or dissimilarity.

The crux of the matter is really this: Is the granulating antigen of the O form the same as, or different from, the granulating antigen of the R form? White and Goyle suggest that they are different, but it is very doubtful if their experiments *prove* that they are different, but, on the other hand, it must be clearly understood that there is no evidence that they are the same.

If, *without the use of heat* (see Table XIV) it could be definitely shown that the serum from a smooth culture, proved both by *in vivo* and *in vitro* tests to contain only the O antigen, did not agglutinate a series of rough strains similarly proved both by *in vitro* and *in vivo* methods to contain only the rough granulating antigens, and that the antiserum for the rough culture so proved did not agglutinate a series of pure (both *in vivo* and *in vitro*) O strains, and if the corresponding absorption tests were clear-cut one could accept the view that the granulating antigen of the smooth strain was different from that of the rough strain.

One experiment described by Bruce White almost proves the contention that the granulating O antigens are different from the granulating R antigens. This finding is summarized thus : "Absorption of the R (rough) serum with the S (smooth) strains (specific and non-specific) and with the

smooth phenol-nasgar (O) culture removed all flocculating agglutinins and all the granulating O agglutinins for the smooth strains. It left almost unchanged the granulating O antibodies—i.e., antibodies to the heat-stable R antigen—for the rough strains."

It is to be noted that the converse experiment does not give such clear indication of difference between the O and R antigens, for it is stated that: "Rough strains grown on ordinary or phenol media do not (or *may* not) absorb all the O agglutinins for smooth cultures from smooth sera."

Here again the old difficulty of accepting receptor analysis as a satisfactory method is encountered, for there is the contradiction—

(*a*) That the O strain used *did not* contain flocculating antigen because it gave only granular agglutination with a flocculating serum.

(*b*) The O strain used *did* contain flocculating antigen because it absorbed the flocculating factor from a flocculating serum. If we ignore the flocculating factors, both in the antigen and antibody, the contention that the O and the R heat-stable antigens are different appears to be valid, for—

(i) Although the rough strains used contain antigen of the O type, i.e., its serum, to some extent at least, agglutinates the O organism, this agglutinin is removed by absorption with an O strain.

(ii) The rough strain used appears to contain another antigen giving granular agglutination. This may be a new antigen, for it is not removed by absorption with the O strain.

We cannot, however, ignore the influence of the flocculating factors, even if they appear, after treatment of the organism by various methods, to be inert, for their very presence in a complex colloidal system introduces complications the influence of which cannot be foreseen.

Let us consider the above in the light of Orcutt's findings on heating flagella suspensions. The findings of that author, so far as flocculating antigens are concerned, may be tabulated thus:—

	Agglutination	Absorption	Antigenic quality
(1) No heat	+	+	+
(2) An intermediate reaction is suggested by the behaviour of the O form in the experiment quoted from Goyle's paper	−	+	+
(3) Heat to 75° C.	−	−	+
(4) Heat to 100° C. (approx.)	−	−	− (usually)

It appears that a progressive physical change is occurring in the flocculating factor as the result of exposure to heat and may perhaps be produced by other influences. It is not impossible that the same may occur with the O heat-stable and the R heat-stable antigens, i.e., the physical condition of either may be such that it behaves according to any of the four following formulæ:—

	Agglutination	Absorption	Antigenic quality
(1)	+	+	+
(2)	−	+	+
(3)	−	−	+
(4)	−	−	−

If in the O form the heat-stable R antigen were in the state indicated under (3) then the results of Bruce White's experiment can be explained without invoking a NEW rough heat-stable antigen, unless one fails completely to produce a serum which will agglutinate the rough antigen by inoculation with a pure O culture. Such an experiment is, apparently, very difficult to perform owing to the fact that without the aid of heat the findings are complicated by the concomitant flocculating reactions which are liable to occur.

A perusal of Table VI of Goyle's communication indicates these difficulties, and shows that an antigen may occur in the condition corresponding to (3) (*supra*). To make clear the position, this table is given *in extenso*.

TABLE XV (TABLE VI, Goyle).

(Quoted from *Journ. of Path. and Bact.*, 1926, xxix No. 2, p. 156.)

Agglutination of N, R and O forms of *B. typhosus* with O *B. typhosus* serum (160 O) before and after absorption with N, R and O (Strain 160 used).

Strain	Form	Titre	Type	Form	Titre	Type	Form	Titre	Type
				Unabsorbed.					
160	N	3,200	fl. g.	R	1,600	fl.	O	6,400	g.
162	N	800	fl. g.	R	800	fl.	O	400	g.
172	N	1,600	fl. g.	R	800	fl.	O	3,200	g.
				Absorbed with N.					
160	N	—	—	R	—	—	O	—	—
162	N	—	—	R	—	—	O	—	—
172	N	—	—	R	—	—	O	—	—
				Absorbed with R.					
160	N	3,200	g.	R	—	—	O	1,600	g.
162	N	—	—	R	100	—	O	—	—
172	N	1,000	g.	R	100	—	O	1,600	g.
				Absorbed with O.					
160	N	1,600	fl.	R	1,600	fl.	O	—	—
172	N	500	fl.	R	800	fl.	O	—	—

fl. = floccular agglutination. g. = granular agglutination. form = nature of colony. type = kind of sedimentation.

The following comments can be made :—

(*a*) The O antigen does not flocculate with this or any other serum. It would appear, therefore, to contain no flocculating antigen.

(*b*) The O form does contain flocculating antigen, for the O antiserum gives flocculation with N and R cultures.

(*c*) The O antigen does not readily absorb the flocculating agglutinins FROM ITS OWN SERUM. This, therefore, is a clear example of flocculating antigen existing under condition (3), and if that be so, it is not improbable that other antigens may exhibit the same peculiarity.

Still assuming that the O and R antigens are essentially different substances it is possible to have the following :—

TABLE XVI.

1 In the O form the antigen may behave thus :—

	Agglutinative	Absorptive	Antigenic
O antigen	+	+	+
R antigen	−	−	+

2 In the R form the antigen may behave thus :—

	Agglutinative	Absorptive	Antigenic
O antigen	−	−	+
R antigen	+	+	+

But these are not the only possibilities, for the reaction could exhibit the following formulæ :—

1′ In the O form :—

	Agglutinative	Absorptive	Antigenic
O antigen	−	+	+
R antigen	−	−	+

2′ In the R form :—

	Agglutinative	Absorptive	Antigenic
O antigenic..	−	−	+
R antigenic..	−	+	+

or—

1″ In the O form :—

	Agglutinative	Absorptive	Antigenic
O antigen	−	+	+
R antigen	−	+	+

2″ In the R form :—

	Agglutinative	Absorptive	Antigenic
O antigen	−	+	+
R antigen	−	+	+

or—

1‴ In the O form :—

	Agglutinative	Absorptive	Antigenic
O antigen	+	+	+
R antigen	−	+	+

2‴ In the R form :—

	Agglutinative	Absorptive	Antigenic
O antigen	−	+	+
R antigen	+	+	+

or—

1⁗ In the O form :—

	Agglutinative	Absorptive	Antigenic
O antigen	+	+	+
R antigen	+	+	+

2⁗ In the R form :—

	Agglutinative	Absorptive	Antigenic
O antigen	+	+	+
R antigen	+	+	+

There is, indeed, one formula that would, if uncomplicated by coincident floccular agglutination, indicate a clear differentiation of the O and the R antigen, viz. :—

O Form :—

	Agglutinative	Absorptive	Antigenic
O antigen	+	+	+
R antigen	−	−	−

R Form :—

	Agglutinative	Absorptive	Antigenic
O antigen	−	−	−
R antigen	+	+	+

There is, therefore, no need to postulate the development of a separate new granulating antigen in the rough form, for that antigen may well be present in the smooth form, but in such condition that it is not demonstrable by the *in vitro* methods employed in the tests.

A problem of greater difficulty is the relationship of the O granulating to the R granulating antigen.

A. Assuming that the O and R granulating heat-stable antigens are different and separate entities, the following possibilities have to be considered :

(1) In the O form the O granulating antigen is dominant quantitatively, but with the change to roughness the R granulating antigen becomes dominant, i.e., one antigen tends to disappear and is replaced by an increase in quantity of another.

(2) In both O and R forms neither antigen need be dominant quantitatively, but, in the O form one, and in the R form the other, may be dominant in a qualitative sense, i.e., becomes more easily demonstrated by *in vitro* methods.

B. If we do not accept the view that the O and R granulating antigens are different and separate entities, there is the alternative explanation, viz. : that O smooth becomes O rough, in which case it would be more accurate to regard the R granulating antigen as a modification of the O granulating antigen, rather than as a *new* antigen developed in the course of roughening and replacing the O antigen.

There is nothing which indicates that this second view (B) is invalid for we know quite well that exposure of antigens to a variety of physical conditions may alter to a very considerable extent their immunological reactions. We know, e.g. (see Tables VI, VII, VIII, IX, X), that the influence of heat is variable from one strain of organism to another, and even variable in the same strain at different times. In the course of culture it is quite probable that similar physical changes may occur, and so the change from smooth to rough, and the alteration of O smooth granulating antigen to O rough granulating antigen may be purely a physical change *occurring in the organism as a whole* and not necessarily a change affecting a single constituent.

Summary.

(*a*) Granular clumping of a given suspension cannot be interpreted as evidence that such suspension is devoid of the so-called flocculating antigen. The clumping which occurs in the process of specific agglutination depends upon so many factors that it is rash to draw any conclusions concerning the presence or absence of a given antigen from observations of the quality of the precipitation which occurs in reactions taking place *in vitro*.

(*b*) The terms "thermo-stability" and "thermo-lability" have not, so far, been defined, and there is evidence that these terms are so very relative that they convey but little meaning.

(*c*) The application of the receptor analysis method to the investigation of rough and smooth strains gives interesting results. It is, however, so fraught with technical difficulties that one should observe a critical attitude

in interpreting the findings obtained by that method. Only when no other possible interpretation can be given can we accept evidence based on the receptor analysis method, as indicating loss of, or acquisition of, "constituent antigens."

(*d*) The suggestion of the writer is that a given micro-organism acts as a single antigen, and that physical change therein may so alter it that it reacts, especially in *in vitro* tests, in a variety of ways. This variation of reaction is, according to the pictorial representation of immunological phenomena, accepted as evidence that a micro-organism is made up of a multiplicity of separate constituent antigens which, it is assumed, are susceptible of analysis by *in vitro* tests. This involves an assumption of doubtful validity, viz.: that *in vitro* and *in vivo* experiments give strictly parallel results.

(*To be continued.*)

INJURIES TO THE JAWS AND FACE: AN OUTLINE OF TREATMENT.

By Captain D. CLEWER.
The Army Dental Corps.

The value of the intimate liaison which has always existed between the medical, dental and nursing services is of particular significance in the treatment of injuries to the jaws and face, and it is thought that a discussion of some aspects of these cases may be of use to many readers of the Journal.

The incidence of maxillary injury in the Army is high, even in time of peace. For example, "The Annual Report on the Health of the Army for the Year 1924" shows that cases of fracture of the jaws take third place in the aggregate of fractures, being only exceeded by those of the clavicle and of the nasal bones.

In peace these accidents arise mainly as a result of falls, blows, kicks from horses or mules, or from boxing, football and gymnastic exercises.

The development of recreational training in recent years may tend to increase the liability to this form of injury, but it is probably balanced by the encouragement of temperance through the expansion of regimental institutes, cinemas, etc.

It will, however, be desirable to consider mainly the treatment of gunshot wounds of the face and jaws, as the care of these cases is undertaken under much more arduous conditions, and methods which have been proved in the stress of war can hardly fail to be of value in normal routine.

Ætiology.

Present-day warfare has very greatly raised the incidence of facial injuries as, apart from what may be regarded as an intensification of the peace risks, we are confronted with the increasing power of explosives, the greater range, precision, rate of fire and concentration of modern weapons, the massed use of tanks and aircraft, trench warfare, and the introduction of the steel helmet.

In a campaign developing into trench fighting the proportion of head injuries will always be much higher than in open warfare, while the use of the steel helmet increases the number of survivors with facial wounds. Low-altitude machine fire and bombing from aeroplanes and tank operations add materially to the risk of facial injury, and fractures of the maxillæ are common sequelæ to an aeroplane crash, the pilot's or observer's jaws being brought into violent contact with guns, instrument board, or cockpit.

In addition, the introduction of the 106 instantaneous "daisy-cutter" and similar fuses has done much to augment face and jaw risks in warfare between highly-organized powers.

Projectiles may be divided into those of high and low velocities. Many may fall into either category, according to the range or distance of the burst from the casualty. Bullets, rifle or machine-gun, and high explosive fragments are usually of high velocity, while shrapnel and spent bullets are of comparatively low velocity.

The amount of destruction of bone is dependent upon the angle of impact, the velocity of the projectile, and the density of the tissue.

Thus, a glancing blow may severely comminute the mandible, while a direct hit at a right angle may completely remove a relatively small fragment.

Actual hits from signal rockets have been observed, and facial burns are frequently caused by petrol ignition in tanks and aircraft, or by cordite fires in dumps or gunpits, resulting from shell-fire or from "prematures."

Secondary projectiles may also do damage, as in the case of stones, screw pickets or pieces of reveting material thrown up by an explosion.

Bayonet wounds of the face are rarely seen.

In all cases left-side injuries are more common, as that side of the face is more exposed when sighting a rifle, but there is very little information as to the frequency of injury to the superior and inferior maxillæ. Some German figures published during the Great War claimed that of every seven gunshot wounds of the maxillæ, five involved the inferior, one the superior, and one both. Of these cases it was estimated that one-quarter could be rendered fit for return to active service within a reasonable period. This proportion is, no doubt, a reasonable one and, in the absence of accurate statistics, may be accepted as a working basis.

Signs and Symptoms.

In simple fracture of the mandible, the usual signs and symptoms, in brief, are pain, abnormal mobility, loss of function, derangement of the occlusion of the teeth, sublingual hæmatoma, and intense salivation.

In many cases one or more of these signs may be absent, for instance, in a vertical fracture through the symphysis there may be little or no displacement. Crepitus may, but should not, be obtained, as much damage may be done to the bony structures as a result.

In the maxilla the same signs are present, except that hæmatoma is not always observed, and many of the abnormalities are less obvious.

In the case of a gunshot wound all these phenomena are usually more pronounced, and are complicated to a varying degree by the destruction or loss of hard and soft tissues.

It must not be forgotten that remote and obscure injuries may have been caused, and these should always be excluded.

As an example, the writer remembers a case in which a fragment of high explosive had entered in the region of the infra-orbital foramen, passed through the hard palate, fractured the body of the mandible on the opposite side, and emerged at an exit wound in the neck. A hard lump was felt

deep in the tongue, and proved to be a disc of vulcanite punched from an upper denture which the patient was wearing at the time he was wounded.

Treatment.

At the risk of stating a platitude, it must be emphasized that, in the treatment of gunshot wounds of the jaws, the first efforts must be devoted to the saving of life, and to this end the dental officer can be of much assistance.

According to the conditions of warfare and the nature of the casualty, he will first see the patient at a field ambulance or at a casualty clearing station.

The normal channel of treatment and evacuation is regimental aid post, advanced dressing station, main dressing station to casualty clearing station; but, according to the nature of the campaign and the military situation at the time, the patient may not pass through the complete chain. Thus, he may be picked up near the advanced dressing station, treated there and, if a motor ambulance waggon is available, evacuated direct to the casualty clearing station.

In a campaign of pursuit, or in difficult country with extended lines of communication, much more may be done at the main dressing station, but normally the ideal unit for definite treatment is the casualty clearing station.

At the first available opportunity the patient will have received an injection of antitetanic serum, and preliminary treatment will be devoted to resuscitation, consisting of measures to combat the three primary dangers in all jaw cases. These are: (1) Dyspnœa; (2) shock; (3) hæmorrhage.

If possible, the patient should be placed in the sitting posture, but if his condition is too critical he should be laid face downwards on the stretcher. The tongue should be controlled, if necessary, by passing a ligature which is secured to a tunic button, and he should be placed in the resuscitation ward or marquee. Warm blankets and hot bottles are supplied and heat maintained by means of a "Primus" or "Beatrice" stove placed under the raised stretcher and surrounded by a blanket screen.

Hæmorrhage is controlled by plugging or ligation of vessels and transfusion of blood or glucose saline performed when indicated.

Camphor in oil, three to five grains hypodermically, is often of value in the treatment of shock, while morphia should be administered with discretion, as it tends to induce laryngeal paresis.

At the earliest opportunity radiographs should be obtained to disclose the extent of the bony injury and the presence and location of foreign bodies. A mobile X-ray unit is normally attached to every casualty clearing station group and there should be no difficulty in obtaining this very necessary aid to diagnosis and treatment.

The anæsthetic of choice for jaw operations is the intratracheal

insufflation of warm ether by the Shipway method, the rubber tube being introduced into the trachea by the nasal route, thus leaving the surgeon a clear field of operation and permitting the packing of the pharynx with swabs as a precaution against the entrance of septic material into the air passages.

If, for any reason, this is impracticable, rectal ether may be employed, but the technique is more complicated and is not so well suited to routine treatment in the field. Should chloroform be used, it must be remembered that the use of adrenalin is contra-indicated.

It is at this stage of the treatment that the co-operation of the dental officer is of value.

Injuries to the soft parts are treated by careful cleansing with picric acid, iodine, or mercurochrome and, whenever possible, by primary suture,

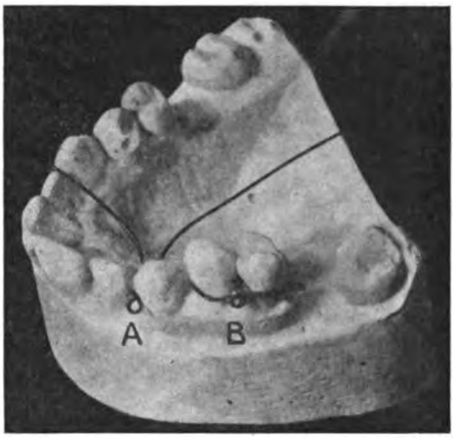


FIG. 1.—A. Looped wire passed between teeth. B. Ends brought round and twisted tightly together.

but, if much inflammatory reaction is present, it may be desirable to wait a few days and then proceed with delayed primary suture. All ragged edges should be excised and smoothed and the parts sutured in close apposition, with a view to minimizing subsequent cicatricial contraction and deformity.

When there is much comminution of bone or other potential cause of sepsis it is desirable to arrange drainage.

The question of what hard tissue to conserve and what to eliminate is one of much difficulty and must be dealt with on the merits of the individual case. As a broad principle it may be laid down that all septic roots, isolated non-viable fragments of bone, and the teeth on either side of the fracture should invariably be removed. This question of the removal of possibly sound teeth, merely because they are involved in the area of fracture, has been much discussed, but the consensus of opinion is that, sooner

or later, they become sources of infection, delay healing, and therefore cannot be allowed to remain.

Whenever the loss of bone is less than two to three centimetres, every effort should be made to secure bony union, as the mechanical advantages of osseous over fibrous repair far outweigh the relatively slight amount of malocclusion which is inevitable; but where the loss of tissue exceeds this amount the field should be prepared for subsequent treatment by bone-grafting.

In either case immobilization of the fragments must be secured, as this aids repair, relieves pain, controls sepsis, and reduces subsequent deformity.

There are so many methods of intraoral splinting, many of which are highly technical, that it is impossible to discuss them in detail within the compass of an article in these pages.

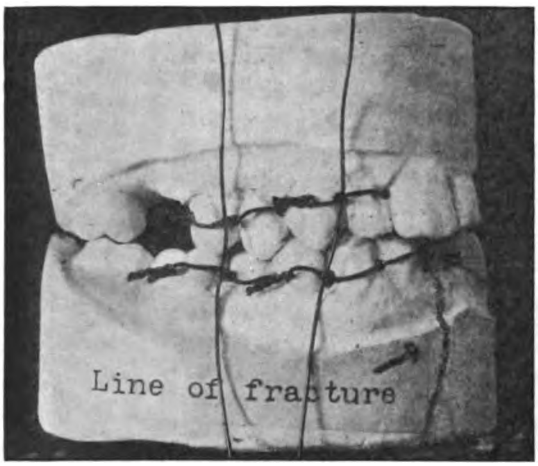


FIG. 2.—Vertical wires passed through loops.

It may be said, however, that surgical wiring of the fractured mandible should rarely, if ever, be attempted, but that the parts should be controlled either by interdental wiring or by dental cap or wire splints, coupled with the aid of some form of external support such as a sling or aluminium chin boot.

It must be remembered that one of the first principles of the medical services in war is the early and systematic evacuation of sick and wounded. Unless casualties are rapidly treated and evacuated, a state of congestion will arise which may seriously impede the course of operations by choking medical units and dislocating rail and motor transport, to say nothing of its disastrous effect upon the *moral* of the troops. The man who has been wounded must be removed to a place of comparative safety as soon as his condition permits, and the troops should have confidence that this will be done.

For these reasons, the writer ventures to suggest that elaborate splinting, requiring careful preparation, is quite out of place in field medical units, and that the expense of equipping them with the necessary apparatus would only be justifiable in the case of positional warfare on a large scale, where "quiet areas" might reasonably be expected.

Intraoral, interdental wiring affords an excellent, speedy and inexpensive method of securing immobilization, provided that sufficient teeth remain *in situ*, and, with the increasing dental care of the soldier, it may be assumed that such cases will be the rule in any future campaign.

The method adopted is the ligation of teeth by means of strands of 24-gauge brass wire. By its use reduction may be secured by binding together two or three teeth on each side of the fracture and uniting the wires into one common strand on each side. These are then twisted up

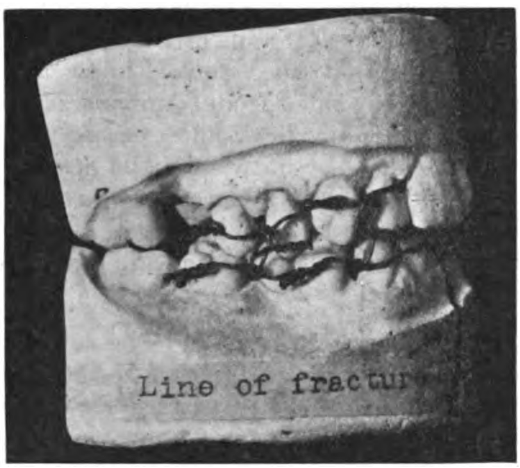


FIG. 3.—Vertical wires twisted up lacing mandible to maxilla, thus securing immobilization.

until approximation of the fragments is achieved. Two or three teeth should always be united in each fragment in order that stress may be distributed and not all thrown upon one tooth.

Where it is necessary to maintain occlusion without bony apposition, the maxillary teeth may be secured to those in the mandible, suitable eyelet twists being first made in the ligatures, through which are passed vertical wires lacing the two jaws together.

An excellent description of this technique is given by Ivy and Curtis, in the *Dental Cosmos*, vol. lxviii, p. 439.

It has been successfully used by the writer, and the accompanying photographs of the models of an actual case may help to explain its application.

In addition, some form of chin support should be fitted, rubber-dam slings being more cleanly and preferable to a four-tail or Barton bandage.

Subsequent care is directed to the support of the patient by two-hourly liquid feeding, *per rectum* if necessary, and constant douching of the oral cavity with mild antiseptics. In this connexion a Higginson enema syringe has been found to be of great value, as it enables an unlimited and powerful spray to be directed into any part of the mouth.

Post-Operative Sequelæ.

The complications most to be feared are acute bronchopneumonia and erysipelas. The former will usually be prevented by careful anæsthetic and surgical technique; the sitting or stomach posture, inhalations of tr. benzoin co., and routine ward attention to irrigation and cleansing of the mouth are prophylactic measures of the highest value in both conditions.

An acute rise of temperature without visible cause should always arouse suspicion of the onset of erysipelas.

The patient is then evacuated and should be transferred to a base or home hospital, where specialized treatment is available.

It is in this connexion that the value of simple interdental wiring is enhanced, as the patient may suffer from train or sea sickness, and it may be of vital importance for the medical officer or sister, without specialized dental knowledge, to be able—by untwisting the strands of wire—to open and swab out the mouth and then replace the wires, although this should, of course, only be done in a case of urgency.

In the absence of suitable pliers, hæmostatic forceps are well suited to the purpose.

Secondary Sequelæ.

Secondary complications are suppuration, secondary hæmorrhage and pneumonia, but these are, fortunately, of rare occurrence when the case has received early and efficient treatment.

Late Sequelæ.

The most common of the later difficulties are adhesions, deformity, and ankylosis of the temporo-mandibular articulation. All these, in so far as they affect the dental organs, may be dealt with by suitable dental appliances, again of types too diverse to be dealt with here.

Late Treatment.

(1) *Hard Tissues.*—Loss of bone may, and sometimes must, be rectified by the supply of a prosthetic appliance, but is best dealt with by autogenous bone-grafting. It is necessary to wait for some twelve to fifteen months after the original injury, and at least three months after the last trace of sepsis, before attempting this operation. A blood test and careful overhaul of the circulatory and excretory systems should first be performed. Deep Röntgen-therapy is of great value in lighting up any traces of latent sepsis.

The graft used should be autogenous, but if, for any reason, this is impracticable, the donor must be Wassermann-negative and of the appropriate blood-group. Heterogeneous grafts are of little or no value.

In modern technique the crest of the ileum is selected as the source of the graft, as it is rich in medullary elements, has a curve approximating to that of the mandible, resembles the latter in structure, and readily forms callus.

Absolute immobility of the fragments is a *sine qua non*, and is usually obtained at this stage by cementing cast metal cap splints to the teeth. Essentials in operation are absolute asepsis, speed (the closure of the ileal incision being left to an assistant), accurate adaptation with exclusion of blood-clot between the ends of the fragments and graft, retention of periosteum on the graft, and the avoidance of any opening into the mouth, i.e., through the mucous membrane on the lingual aspect of the jaw. Some form of step or peg lock is usually provided.

Some writers advocate the subsequent administration of vitamins C and D, calcium, or thyroid extract, as tending to promote the formation of callus. Splints should be retained for at least six to eight weeks and drainage provided for the first few days.

Chubb reports ninety-three per cent of successes in bone-graft operations.

(2) *Soft Tissues.*—In plastic operations for the repair or replacement of soft parts, the same general principles of technique apply.

Plastic repair of these tissues may be performed by means of:—

(i) Thiersch grafts.
(ii) Wolfe grafts.
(iii) Pedicle grafts.
(iv) Tube flaps and grafts.

A Thiersch graft is a surface shaving of skin, not including any hair follicles, and is used in the restoration of mucous membranes. It is best taken from the upper arm over the biceps.

A Wolfe graft is a whole thickness skin graft and is used for the restoration of skin in parts exposed to view or to friction.

A pedicle skin graft is a small strip, one end of which remains attached to and derives nutriment from its source, while the other is utilized to remedy some minor defect.

A tube flap is a long strip in which the lateral margins are united in the form of a tube, as it is found that such tubes have more vitality. They are used for conveying tissue from distant parts, e.g., from the scalp, neck, or chest, to the face.

There are various modifications of the tube flap, such as: (*a*) "Caterpillar" flaps in which the flap, not being long enough to reach the required destination in one operation, is first grafted, and later, when union has been effected, is dissected at the distal end and "stepped" to the final position; (*b*) "tube grafts" which, after dissection at one end, are allowed to hang

for two or three weeks, when they acquire a permanent roseate colouring and are used for the restoration of the lips; and (*c*) "double tube flaps," where one flap, of hair-free skin, is turned with its epithelial surface to the interior of the mouth and the raw surface outwards, to which a second flap is immediately applied. This modification is designed to prevent the introduction of hair-bearing tissue inside the mouth and is of value in the restoration of the cheeks, etc. In this and other cases, hair-bearing tissue may be conveyed from the scalp when desired, and the resulting growth often aids the cosmetic effect.

Accuracy of adaptation is essential and is secured by the maintenance of pressure or by suture, and the dental officer can often render assistance in the case of Thiersch and Wolfe grafts and in rhinoplasty by devising apparatus anchored to the teeth and arranged to secure constant pressure or support to the parts under treatment.

In the late treatment of cicatrices much assistance may be afforded by Röntgen or radium-therapy.

Local anæsthetics may be used for minor plastic surgery, but as they lower the local resistance they may determine the death of the graft, and these operations are, as a rule, better conducted under general anæsthesia.

It is probable that judicious ultra-violet radiation of the area preparatory to taking a graft would be of value in raising its resistance.

In cases where none of these methods can be applied with success, it may become necessary to supply a facial mask, and this may be constructed of thin metal by the process of electro-deposition, of vulcanite, gelatine, paraffin wax, etc,.

General Aids to Treatment.

(1) *Diet.*—This question is a very important one, and every effort should be made to ensure that, even when liquids are given, the diet is varied and nourishing. Later, as function is restored, a steady increase in the masticatory effort is called for, and the diet should be progressively graduated accordingly.

(2) *Maintenance of Moral.*—There are few conditions more damaging to the patient's mental attitude than a prolonged period of immobilization of the jaws, coupled, possibly, with an almost endless series of minor operations for plastic restoration.

Tonics and general supportive measures are called for, and every facility should be given for suitable recreation.

Light manual exercise, duties or physical training, libraries, games, concerts and hobbies, are all of the greatest value in this connexion.

Conclusion.

Although this article is chiefly devoted to the active service aspects of jaw and facial injuries, it is hoped that it may prove of some value in routine treatment under everyday conditions.

Apart from personal experience, the publications of many writers have been drawn upon in the course of compilation, and the writer trusts that they will accept the bibliography as his acknowledgment, and that interested readers may find it of value should they desire a more detailed account of surgical and dental methods than is possible in these pages.

He is much indebted to Lieutenant-Colonel G. E. Cathcart, O.B.E., R.A.M.C., O.C. Military Hospital, Gibraltar, and to Colonel J. W. Langstaff, D.S.O., D.D.M.S., Gibraltar Command, for their permission to publish these notes.

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Editorial.

DROPLET INFECTION.

In an editorial published in the September number of this Journal we commented on the attempts to solve the problems of the onset and decline of infectious diseases by experimental studies of closed communities of animals, carried out by Professor Topley and Major Greenwood.

A paper on "Droplet Infection in Semi-closed Communities," by Surgeon Commander Dudley, and published by the Medical Research Council, gives the results of studies of the spread of infectious disease in semi-closed communities of the Royal Navy. The conclusions as regards the fluctuations in herd immunity and its relation to the introduction of new elements of population, strikingly confirm the conclusions reached by Professor Topley and Major Greenwood in their study of infected mice maintained in close communities, which could be increased or diminished at will.

The theory of droplet infection is not new: it is nearly forty years since Flügge maintained that the spread of tuberculous infection was mainly through infected droplets ejected during speaking and coughing, and rarely by the inhalation of dried bacilli, championed by Fränkel as the main source of infection.

Passing years have only served to confirm the belief in Flügge's hypothesis, not alone for tubercle, but also for other infectious diseases.

Dudley's studies were carried out at the Royal Naval School, Greenwich, where about 1,000 boys, aged 11½ to 15½, occupied as sleeping quarters nine airy rooms, each containing 70 to 126 beds, with a floor space of 40 square feet, and a cubic space of 500 to 600 feet per bed. The distance between the heads of the beds was one foot, but as far as possible arrangements were made so that the boys slept head to foot. The boys remain in the school three years. New entries join in batches of thirty to fifty boys three times a term, but are kept for three weeks to a month in buildings quite separate from the rest of the school to prevent the introduction of infectious disease. The schoolrooms are large and compare favourably with those of most County Council schools. Sanitation, food, milk and water supply are above suspicion.

In addition to the ordinary residents, about 100 day scholars attend the school and mix freely with the boarders during work and play.

In this community, during the period 1912-24, or thirty-eight school terms in all, the average annual attack rate per 10,000 boys was as follows: Sore throat, 1,378; influenza, 1,200; scarlet fever, 334; diphtheria, 224; rubella, 140; mumps, 104; measles, 27. These attack rates are much higher than among the general population of a similar age.

As regards influenza, catarrh and influenza are entered separately in the sick records. The type of influenza that infected the school was commented on in all the reports as being free from catarrhal symptoms and was definitely distinguishable from catarrh. Ninety-three per cent. of the cases occurred in four epidemics, and the symptoms, acute frontal headache, with three or four days fever and absence of pulmonary complications, were similar in all four epidemics. In the Navy the infecting complex varied from place to place, but remained fairly constant in a semi-isolated community such as a school or ship.

In the Greenwich Naval School new boys were not allowed to mix with old boys until they had been segregated for three weeks or longer in a separate building. There were no cases among the new boys so isolated.

In the outbreak of 1924 forty new boys were distributed indiscriminately throughout the school on the twenty-third day of the epidemic. On the twenty-sixth day two of this batch developed influenza, and within a week nine new boys had been infected. Meanwhile the incidence among the old boys, which had previously been on the wane, rose again, and sixteen infections appeared among boys who had had influenza earlier in the epidemic. There had been no second attack among the old boys previous to the introduction of the fresh, susceptible new boys. This experience is almost an exact parallel of the experiments with typhoid-infected mice, carried out by Topley, who found that the introduction of uninfected mice into a mouse population towards the end of an epidemic of mouse typhoid is followed by (1) mortality among the freshly introduced mice, and (2) a recrudescence of mortality among the survivors of the epidemic. The use of mortality as an index of infection in the mice led to the same conclusion as the use of morbidity for the same purpose among the Greenwich boys; and the same law of the spread of bacterial infection was followed in two widely different complexes of host and parasite.

Only one outbreak of mumps of any magnitude occurred in the twenty-two terms; the incubation period is so long that, unless the outbreak starts very early, it is liable to be cut short by the intervention of the holidays before a sufficient number of centres of infection have developed.

Rubella was responsible for two outbreaks, with an onset so explosive that it could only be explained by supposing that the recorded cases were infected by missed cases or carriers.

In the Greenwich Naval School the average incidence of diphtheria from 1914 to 1924 was more than four times that prevailing in a slightly younger group of London school children. Most of the Greenwich boys are recruited from the Board schools, and when tested by the Schick test for herd immunity showed the same percentage of negative reactions as the boys of similar age in Board schools, and yet these best specimens of County Council boys transferred to another environment suffered from a morbidity more than fourfold that of similar boys who remained in the original environment.

The figures for scarlet fever are almost identical with those for diphtheria.

The greater prevalence of infectious diseases in the Naval School than in day schools is regarded by Dudley as evidence that the spread of infection was easier in the sleeping quarters than in the class-rooms or playground. This assumption is supported by the fact that there were no known cases of diphtheria or scarlet fever among the day boys in the Naval School, who were all over 11 years of age and worked in the same class-rooms.

In contrast to diphtheria and scarlet fever the attack rate of measles and chicken-pox was low, and outbreaks of any magnitude were never produced. This low incidence is attributed to the fact that most of the residents are over 11 years of age, and in England and Wales the whole of the morbidity from measles and chicken-pox falls on children under 10. In these diseases also the carrier state is either non-existent or very rare, and in sleeping quarters where immunes greatly outnumber the susceptibles the former will tend to insulate a case from contact with the latter.

On the subject of bed to bed infection, Dudley refers to the observations of Glover, who found that in a military population a distance of two and a half feet between beds was sufficient to prevent the spread of cerebro-spinal fever. There were only two cases of this disease in the Naval School when it was rife in the military population. A distance of three feet between beds, however, failed to prevent the spread of diphtheria and scarlet fever in the Naval School. Experience with bed isolation treatment teaches that young children will rarely infect each other with diphtheria or scarlet fever when there is a distance of nine feet between the beds, but even a distance of twelve feet will not prevent cross infection in early measles and chicken-pox.

In naval depots diphtheria and scarlet fever are always a source of anxiety, but by the time recruits go to sea, where they are mixed with older men, the herd immunity, i.e., the resistance of the community to infection, is so high that scarlet fever and diphtheria are almost unknown on battleships, although the men sleep in hammocks slung only eighteen inches apart.

In the Naval School it was shown that there might be a high carrier rate for diphtheria and a negligible morbidity rate, although at a previous time, when the carrier rate was low, the same community had suffered from a large outbreak of diphtheria. The fact that the population had acquired a high degree of immunity during the epidemic was not regarded as completely explaining the circumstance that many virulent diphtheria carriers might be present at the time morbidity was absent, while 150 fresh boys were being added yearly to the community. Diminution in virulence of the *Bacillus diphtheriæ* was suggested as an explanation, but of this there was no evidence; the ratio of virulent to avirulent bacilli was even greater in the post-epidemic time than during the epidemic. Another

suggested solution of this problem was the presence of the non-dangerous carrier who never exhales microbes fast enough to cause symptomatic infection. But carriers from the school were known to have caused diphtheria at home, and virulent bacilli were always easily isolated from the carriers. Dudley thinks that to understand the relation between the carrier and herd immunity it is necessary to realize the part played by time in the production of parasitic infection. There are three variables: (1) The amount of infective material received by the host per unit of time; (2) the rate at which the infective material can be destroyed; (3) the rate at which the microbic proteins stimulate (or depress) the immunity mechanisms (specific or non-specific) of the host. The first two variables are connected with the theory of velocity of infection, which is the difference between the rate of reception and destruction of microbes. If the rate of reception is greater than the rate of destruction disease will result, if the patient stops long enough in the environment; if less there may be no actual illness, and the body may be stimulated by the microbic proteins, and the defence mechanism increased so that eventually the body may have a greater power of resistance than previously. Possibly the carrier state may result if the distance between the recipient and distributor is diminished, so that the dose is increased but not sufficiently to overcome the defensive mechanism and produce disease. Glover showed that though disease did not arise, carriers of cerebro-spinal meningitis were produced when the beds were two feet six inches apart. Other things being equal, including time, it seems to depend on the distance of a susceptible host from the distributor of parasites whether the former becomes a case, a carrier, or immune to infection by merely destroying or absorbing the parasitic proteins. Dudley appears to think that carriers acting in a suitable environment may prevent large outbreaks of disease by supplying subinfective doses of infectious material to the more susceptible members of the population. In this way the general resistance to epidemic resistance is increased and the herd is vaccinated by its carriers. He does not suggest that carrier infection is the only mode of distribution of microbic disease, and points out that many parasites, such as that of small-pox, rarely, if ever, use this method of dissemination, and it is the absence of carriers combined with an incubation period long enough to allow preventive steps to be taken that enables small-pox to be controlled by careful quarantine measures, measures which prove hopeless in the control of such diseases as meningitis, where carriers far outnumber cases.

The rate at which susceptible material is added to a community must have a large influence on morbidity, but it was not until the statistics of Greenwich Naval School and Shotley Naval Training Establishment were compared that any idea was obtained of the magnitude of the effect of rate of change of population. The environmental conditions at Shotley were rather better than those at Greenwich. The recruits at Shotley were older and came from a slightly poorer class than the Greenwich boys; the herd

immunity at Shotley should therefore have been higher than that at Greenwich. The morbidity from infectious diseases, however, was practically as high at Shotley as at Greenwich. The reason for this was that the population at Shotley was changing three times as rapidly as at Greenwich. The rate of change of a population is of special interest to the Services; it is probably the chief factor in the high incidence of disease in recruiting depots, and is of far more importance than unaccustomed conditions of living or mental and physical strain.

A good example of the effect of rate of change of population on incidence is seen in the epidemic of meningitis in the Royal Navy during the Great War. Sir Humphry Rolleston thought the strain of new conditions was much more important than age, for if age alone were the determining factor the incidence of the disease among the boys in the "Impregnable," "Powerful" and Shotley Barracks should have been much higher than 14·6 per cent of the total (555) cases in the Navy.

Dudley points out that the percentage of total cases is no indication of the real attack rate, because the different population groups varied so much in numbers. The percentage of the total naval cases at Shotley was less than half that of sea-going ships, yet the real attack rate was twenty-eight times as great, while in the "Impregnable" the morbidity from cerebro-spinal meningitis was six times as great as at Portsmouth Barracks, although the actual number of cases in the barracks was double that in the training ship. At Greenwich Naval School, where the sleeping arrangements were comparatively good, cerebro-spinal meningitis gave little trouble, while at Shotley, where the sleeping arrangements were better and the boys older, the incidence of cerebro-spinal meningitis was ten times as great, which must have been due to the fact that the rate of change of the population at Shotley was three times as great as at Greenwich.

Dudley does not discuss the periodicity of disease at length. He admits the criticism might be made that the different attack rates in the same and different establishments were waxing and waning with the general incidence outside, and that the prevailing infectious morbidity outside was a more important factor in determining the total mass of infection in an establishment than the differences in the environmental and other characters peculiar to the institution itself. Tables showing the incidence of infections at Greenwich, Shotley, and in H.M.S. "Impregnable" for the same years, before, during and after the war, did not indicate any noticeable or constant difference in the attack rates in these institutions at any of the periods mentioned. The war increased the ease with which bacteria are disseminated by increasing the movement of populations and diminished the resistance of the community, yet, whatever the effect on the public health might have been, the effect on the incidence of disease in the naval institutions was too small to make any noticeable impression on the statistics of the infections studied. There was no correspondence between high and low years in the different institutions, and the lack of synchroniza-

tion in the periodicity of disease in the different naval establishments suggests that the annual morbidity in them does not wax and wane with the general annual morbidity of the country as a whole. The incidence of infectious disease in a semi-isolated community will apparently pulsate at its own rate, but the pulsation may increase in amplitude as the crest of the wave of national morbidity passes over the contained community. The more epidemic the disease the more the local outbreaks will bear a relation in time to an increase in general prevalence. But the differences in the morbidity of the various establishments which have been studied are determined much more by the intrinsic characters of the establishment than by the density of disease in the surrounding area.

The chief practical lesson brought out by the research is that the individuals of a community should be isolated from each other to the greatest possible extent in their sleeping quarters, and especially should this be the case in those communities to which many susceptibles are frequently added.

Six feet of wall space, i.e., three feet between beds, in military barracks has been the rule since the Crimean War, and it was the infringement of this rule, owing to the stress of war, that led to the outbreak of cerebro-spinal fever in certain barracks at home during the Great War.

The lesson to be learnt by military hygienists is the influence which frequent changes of the population may have on the outbreak of infectious disease. The circulation of non-immune recruits in depots and barracks where certain infectious diseases have been prevalent, but at the time are subsiding, may cause not only an outbreak of disease among the new entrants but also among the old members of the community who had already suffered from the disease in question.

Clinical and other Notes.

A SIMPLE AND EFFICIENT METHOD OF ERECTING MOSQUITO NET WIRES.

By Lieutenant-Colonel L. REYNOLDS.
Indian Medical Service.

Two wires are stretched across the room at a suitable distance from each other, attached at each end by hooks to the walls (see fig. 1).

A stout lath of wood (a wood pole from a mosquito net frame does

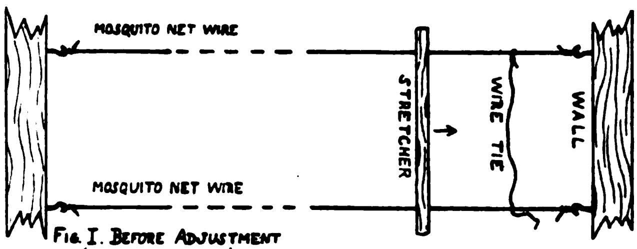

Fig. I. Before Adjustment (seen from above)

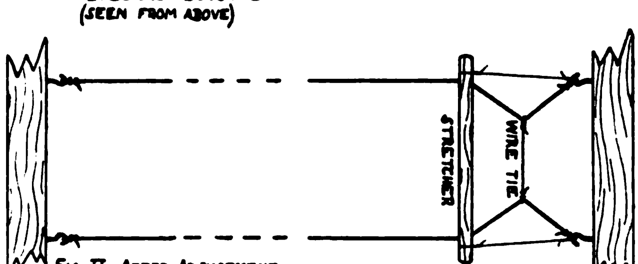

Fig. II. After Adjustment (stretcher drawn along and made fast near wall, wire tie drawn taut)

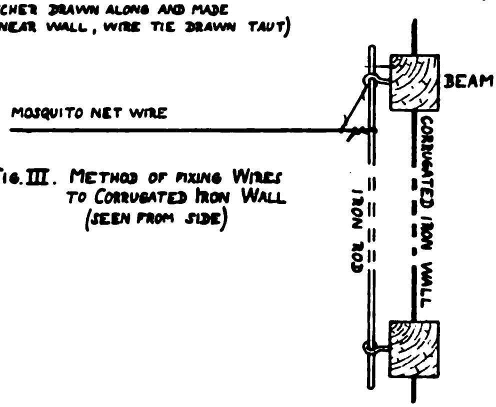

Fig. III. Method of fixing Wires to Corrugated Iron Wall (seen from side)

admirably) is laid across the wires and attached to them at each end by a wire loop, so that the lath can ride on the wires backwards and forwards. This wire stretcher is placed about eight feet from the wall.

A piece of wire is now fastened to one mosquito net wire about eighteen inches from the wall (see wire tie, fig. 1). The loose end of this wire is then brought over the second mosquito net wire, pulled tight so that the two mosquito net wires are drawn together, and then fastened off.

To adjust the wires, the stretcher is now forced towards the wall (see arrow, fig. 1). The nearer the stretcher to the wall, the sharper the angle of the wires at the wire tie, and the tighter the mosquito net wires become (fig. 2).

When the wires are sufficiently tight the stretcher is kept from slipping back by small pieces of wire attaching the ends of the stretcher to the hooks in the wall (see thin lines, fig. 2).

All the wards in the Indian Station Hospital, Maymyo, Burma, were wired by me in this way for Rs. 35, the price of the wire and hooks. The estimate for wiring in the ordinary way was Rs. 800.

At the end of six months only two wires required readjustment, a matter of a few moments.

The walls of this hospital are of corrugated iron, and beams which are never in the right place for the hooks. Fig. 3 shows how this difficulty was overcome. An iron rod (iron mosquito net poles were used) was fixed to two beams by iron hooks and wire, and the mosquito net wire fastened to this iron rod at the correct height. If the iron rod was vertical, this wire was prevented from slipping down by a short wire attached to the hook above (see thin line, fig. 3).

The galvanized iron wire should not be too thick, otherwise it is difficult to work with and adds unnecessarily to the expense.

The mosquito nets hang from the wires by their tapes. Patients soon learn how to fold up the net, roll it into a neat bundle and attach it to the mosquito net wire when not in use.

By this very inexpensive plan the wires are kept more taut than by any other method that I have seen. In fact they may be tightened until the stretcher breaks, the wires snap, or the hooks come out of the wall. Such tension is, of course, quite unnecessary.

DIFFICULTIES IN THE DIFFERENTIAL DIAGNOSIS BETWEEN RABIES AND NERVOUS FORMS OF DISTEMPER.

By Captain S. J. L. LINDEMAN, M.C.
Royal Army Medical Corps.

The differential diagnosis between rabies and nervous forms of distemper in dogs is still very uncertain, and is often of extreme practical importance. Both diseases are very prevalent in many parts of India, and to mistake a case of rabies for distemper may have very disastrous consequences, while the reverse will cause a great deal of unnecessary discomfort and worry. The following cases which have occurred recently in Karachi illustrate the

difficulties. In May, 1926, I had a well-bred cocker spaniel bitch and two puppies, the last of a litter of ten, born December, 1925. The remaining eight puppies had been sold. There was also a full-grown fox terrier dog living in the house. All the dogs had been very carefully looked after, and it is certain that none of them had been bitten. In April, 1926, both puppies had been inoculated with three doses of antidistemper vaccine in tabloid form.

On May 22 pup "A," at 3 p.m., suddenly had an epileptiform fit, i.e., its jaw began working, it frothed at the mouth, fell down unconscious and became rigid all over; it recovered consciousness in about a quarter of an hour, seemed dazed and sleepy, slept for a few minutes, and woke up perfectly well and normal in every way. It remained well all day, playing and eating as usual. At 12.30 a.m., on the 23rd, it had another fit, followed by a rabic period lasting twenty minutes, in which it ran round in a frightened manner, obviously unconscious, with a high-pitched yapping and knocking into furniture, etc. It showed no tendency to bite anyone or anything, and in half an hour it was again normal, jumping up its master, drinking water and eating food. It was taken down to a local veterinary hospital tied up in an open stable, and by morning had broken the single light chain catch and run away. On the 26th the pup was found and brought back; it was very dirty and thin, but seemed normal. It had a sore at each corner of the mouth as if it had been biting through a rope with which it was tied up. It ate food and remained normal all day; at 10 p.m. it had another similar fit, followed by the same rabid period and return to normal within half an hour. It was then sent back to hospital. On the 27th it had two fits, and was treated with bromide and chloretone, and had no more fits. On the 28th the pup looked dazed, and clonic spasms of the muscles of the jaws started, also a distinct weakness of the hind quarters. On the 29th choreic movements of the jaws were well marked, he was paralysed, and could not stand, and did not recognize his master, but had no more fits, and was eating his food. On the 30th the pup was destroyed. He had been seen by three vets., who all said these symptoms did not suggest rabies and diagnosed worms or distemper. Post-mortem examination showed all internal organs normal except slight congestion of the small intestines—no worms. The meninges and the cerebral cortex were acutely congested. Part of the brain was sent to the Pasteur Institute at Kasauli and Bombay, both of whom reported: "Negri bodies found, positive rabies."

On receipt of a positive finding persons who had been licked were inoculated, while pup "B" and the adult dogs were shut up under observation. On June 22, 1926, pup "B" was noticed to be ill with fever, an eruption on the abdomen, and a slight weakness of the hind quarters. In view of the diagnosis of "A" it was considered this was the beginning of rabies, and the adult dogs were destroyed, though apparently perfectly healthy.

On June 23, 1926, choreic movements of jaws, head, and hind limbs commenced, and rapidly got worse, followed by paralysis of the hind quarters. There were no fits, and he continued to eat well, but by July 4, 1926, he was in such a pitiable state with the chorea and paralysis that he was destroyed. Post-mortem: liver slightly congested and soft, and a few *Tænia marginata* in the small intestine, otherwise nothing abnormal discovered.

The report on the brain was "No Negri bodies, rabies unlikely."

On June 28, 1926, pup "C" of the same litter, sold four months previously, living in the same station, but not in contact, developed exactly the same fits as pup "A"; the fits lasted for about four days, and were more frequent than in the case of "A"; no more fits occurred after the fourth day, but chorea and paralysis followed.

Special care was taken not to destroy this pup, and it died on July 20 or the 22nd day of disease. Port-mortem examination showed general congestion of the lungs, liver, kidneys, stomach, and brain. Examination of the brain showed "Negri bodies, positive rabies," and it is unfortunate that inoculation tests were not carried out owing to a laboratory mistake.

The important points about these cases are :—

(1) The adult dogs would be more likely than the puppies to contract rabies first, while the puppies were just at the age at which distemper is so common.

(2) Pup "A" and "C" had fits, and Negri bodies were found, while "B" apparently had the same disease, but no fits, and no Negri bodies were found.

(3) Epileptiform fits followed by a return to normal are not described as symptoms of rabies, neither is chorea, though both are described in nervous distemper.

(4) "A" was destroyed after eight days, and presumably would have survived a few days longer. "B" was destroyed after twelve days, while "C" died after twenty-two days. Now it is laid down in the textbooks that any dog which survives eight days from the commencement of its disease cannot have rabies, and this point is often taken into consideration in deciding whether people who have been bitten or licked need be inoculated.

To sum up it appears that on clinical grounds all three had nervous distemper, and the question remains whether Negri bodies are actually diagnostic of rabies or whether they do occur in some forms of nervous distemper. I am informed that it had been suggested that Negri bodies do occur in distemper, but that most of the workers in Pasteur Institutes consider that such cases are actually rabies and not distemper; it would appear that the question could be settled by some careful inoculation tests combined with clinical observations. If these cases were rabies, the symptoms were very definite, and should be described as occurring in that disease, and the fact broadcasted that a rabid dog can survive twenty-two

days, whereas, if they were cases of distemper, a number of people could have been spared the unnecessary, and none too pleasant, course of inoculation, while valuable dogs need not have been destroyed.

THE REGIMENTAL WATER-CART.

By Major S. M. HATTERSLEY.
Royal Army Medical Corps.

The accompanying photographs show the damage done to the clarifying reels of a regimental water-cart when the relief valve on the pump fails to act.

My only reason for publishing them is that various persons who have had experience in working the water-cart and have seen these reels, seem surprised that they can be damaged in this way by the pressure of water in the cylinder.

I am indebted to Regimental Sergeant-Major R. G. Leggett, D.C.M., R.A.M.C., for taking these photographs for me.

Echoes of the Past.

AN ARMY SURGEON'S EXPERIENCES IN SOUTH AFRICA, 1843-46.

EDITED, AND WITH A FOREWORD, BY H. B. NEWHAM, C.M.G., M.D.
Late Temporary Lieutenant-Colonel, Royal Army Medical Corps.

(*Continued from p.* 235.)

Camp. Fort Cox,
Base of the Amatoli Mountains.
August 16*th*, 1845 (*Sunday*).

George Cowley, Esquire, Winslow, Bucks, England.

MY DEAR GEORGE

After passing through some tough scenes since we left Cantonments at Fort Beaufort, I find half an hour to spare, knowing you will be anxious to know how I get on.

Our Division left for the Amatoli Mountains, the great fastness and stronghold of the Enemy, on 26th July—arrived at Block Drift, where we have a Post, that night, some time after dark. Started for the scene of future operations an hour before daybreak, and got to our place about 3 o'clock afternoon.

We encamped on the Flats, and saw good numbers of the Enemy, on all the overlooking points; at too great a distance, however, to get a shot at them. They called out for us to come on, and that we should feed the Wolves and Jackals of the Valley.

During the two following days we were making preparations, and communicating with Sir Andreas Stockenthom, the Commandant and General of the Burgher Mounted Force, principally Dutch Boers. He has about 2,000 with him, and a motley herd of Coloured Natives, which may amount to 2,000 more.

He had taken up position on the other side an enormous basin called the Tyrunie Rock, surrounded on nearly all sides by lofty mountains called the Amatoli.

On the night of the 29th July, our Camp was attacked, and one man killed near me, and a ball put into the waggon where I lay.

On the 30th, at daylight, we ascended the Mountain with two large, and one small gun, and a force about 3,000 strong, consisting of a few 7th D. Guards, and Cape Corps, Artillery and Engineers, 27th and 91st, about 200 each of these. Then came Burghers, Fingoes, Hottentots, etc.

We threw the Fingoes and Hottentots immediately into the Bush, and crowned the open space at the top of ridge ourselves. Firing instantly commenced, Sir A. S.'s party being engaged at the other side of the basin,

which was about ten miles long, and 3 or 4 wide, the sides covered with dense underwood, and close to the top with large timber trees.

The firing was kept up without intermission for about 6 hours, and when I tell you our Division fired 25,000 rounds of Cartridges, you may fancy the rattle. I had a shot at a Caffir early in the day, but missed him, although I think he must have been wounded by my ball, or he would have tried to kill me.

I was sent back by Col. Hare to see a wounded Fingo, and meanwhile the division had proceeded on along the ridge.

One of the Fingo men who went back with me I left with the wounded man, and was returning slightly in advance of the other when I suddenly came across a Caffir.

My horse being at a gallop at the Moment, as I had just discovered the division had moved, I checked him a little, and let drive for my life, as I judged there were more men near him. For the smoke I could not see him for an instant, but my impression was that he had fallen. He escaped into a Bush, and, while I was charging again, two fellows appeared, well inclined to intercept, and kill me, but I think, taking fright at my calling out "Fingoes, shoot them," and the heads of some women appearing just then set them to flight. I tried hard to have a crack at them, and we had a race for it. They beat me shamefully, although I was well mounted, and did not spare steel. Towards the finish I heard a cheer and a party of ours on a rise, who were looking at the race, their attention being called by the shots in their rear.

About 40 Caffirs were killed by our party, and the same by the other; 5 were killed on our side, and 6-8 wounded, 3 severely. No white men were killed or wounded. We moved here in three days afterwards, and since then I have been out on the Buffalo Mountains for four days, the last day without anything to eat or drink, and the first night we had a severe frost. Old Highland Sportsmen said they were never out so cold a night, and the following day proved intensely Hot, with a scorching wind, and all day we were clambering up precipices. We took some Cattle and Horses and burned about 200 Kraals. The Caffirs scarcely showed at all, and never allowed us a shot at them.

The General, with the two other divisions was employed on the other side of the Mountain, on these days, but the Caffirs would not fight.

Our people, in a small number, were out patrolling the day before we started, and were sharply attacked, one seriously wounded, and 3-4 slightly; they killed nine.

On the day of our return to Camp I was attacked with Swelling of the Face and Fever, attended with total prostration of Strength; this lasted for 5 days, but, thanks to God, I am nearly stout as ever again. Several of the men suffered in the same manner; I suppose from sleeping out in such weather. I had also a bad preparation for this distressing march, having had no rest for 3 nights before, being in attendance on my friend, poor Lewes, who died, much regretted by all.

They fire into the Camp every night lately, as there is no Moon, but we are all accustomed to it now, and do not stir.

To-day they have taken away some Oxen, and fired at the Herds. One man killed while lifting water two or three evenings ago. He went after Sun-Down contrary to orders. They send women in to ask for peace, but are told they must first deliver up their arms and the Colonial Cattle.

Got the "Era" but have recd. no letter for a long time from you.

The 2nd Battn., 45th, we are glad to hear, have arrived; this will lighten our duties.

Colonel Johnstone, of ours, is just now starting in Command of 1,000 men, about 200 27th Regt. from the General's division, and Sir A. Stockenthom, with about 2,500 Boers, to cross the River Kei, and punish the Chief Krieli, who has received the Colonial plunder, and the Chiefs Pato and Umtalla, into his Country.

I should tell you I am Senior Asst. Surgeon, 27th vice Delmege promoted on the Staff, and as Mostyn is at home am in Charge of the Regt. in the field. I happen also to be Senior in Charge of this Division, which entails a rather serious responsibility.

Ill as I was, I kept and done my work, although the other two Asst.-Surgeons kindly offered their services.

We get on very well, Col. Hare, and Major Smith, of ours, who is acting Ds-Quarter-Master-Genl., are great allies, so I get what I like done most smoothly, or, as you would say, *Comfortably*.

. . . .

You would scarcely know me in Camp Costume. My face very brown at its upper part, and towards its lower, a Mass of Sandy Beard, Shaving being quite out of the question; while in the field your face scorched all day could not stand the Night Frosts; this is, you must remember, our Winter.

. . . .

I should send you a paper now and then, but cannot, as they have to be Post Paid, and the Mails are very uncertain, and will not take Papers if they can help it, from their great weight, and the Chance of being attacked.

. . . .

An express starts at daylight for the Colony. I therefore must close.

The War is soon expected over, as we have about 12,000 men in the field, and the tribes are greatly punished and broken, although still game to plunder when they get a chance.

Remember me most kindly to the Governor, who is, I sincerly trust, in his usual good health. Tell him, although I am in dangerous scenes daily, yet I hope one day to drink a glass of Wine with him; and tell him of things sufficiently foreign to England to be interesting, if not entertaining. I do indeed look forward to this, and a quiet chat at the Parlour fire with

you, but if I fall, I trust it will be doing my duty faithfully by Merry England.

Then for the present Adieu, and believe me as ever

Yours very faithfully and sincerely,

W. N. Irwin.

George Cowley, Esqre., Winslow, Bucks.

Castle,
Cape Town,
August 28*th*, 1845.

George Cowley, Esqre., Winslow, Bucks, England.

My Dear George,

We have been here for nearly three weeks and very soon expect our relief. . . . This is a clean, well-built town, the streets crossing each other at right angles. The inhabitants very gay, but I do not join much in it, and keep myself to my own set.

Our Natal Division has joined us and are a fine lot of fellows, My namesake in particular. He is really very well looking, and altogether a stylish looking soldier. Baynes and I take long walks about the mountain together, he is not at all reconciled to the Customs yet. The neighbourhood of the Town is very handsome with villas, etc., built principally for the Indians who come to recruit their health and spend some loose cash. The way these fellows live is absurd, they care not what anything costs and are accompanied by a host of their native servants in all their variety of costume. I have not seen many handsome women, although I believe I know every person here who is in Society.

Our duties here are not very heavy, the worst of mine is to have to attend Church Parades in full Regimentals. Delmege, my senior, does all the Hospital work, leaving the Ladies, Women and Children to me. He likes not to attend these and I do. I have quarters in the Castle, which commands the Bay. I have been long expecting a letter from you, but I hope you are all well, pray remember me to all friends. I never was better, am just able to keep afloat and snap my fingers at Duns, live in fellowship with all my brothers and sisters, like my Colonel well and his wife better, read for an hour or two every day in a splendid Library, saunter about Town or ramble about the Mountains. Dine at my Mess and drink very moderately, go to my room and smoke a weed with some one and retire to my virtuous couch; thus life is exercised here. . . .

On leaving the frontier we had several Balls, Soirees, etc., given us at Algoa Bay, and I saw some very nice people there, and one or two most beautiful Angels in white satin, but escaped, although I came out rather strong in returning thanks at a Supper and the health of Colonel Johnstone and the Officers of the gallant 27th being drunk, the proposer hoping we might continue to win laurels as we had won hearts. You may fancy what I said! I assure you the noise was something fearful.

The vessel which was to take the Mail does not go for some days, so I shall not yet close.

September 11*th*.

A vessel arrived yesterday, bringing news to the 19th July! What a fearful state Ireland is in and about my former home particularly.

We expect our relief in about fourteen days. I have no great desire for it as a man may as well spend his time abroad as at home, that is, if he have a loose leg and no ties, but I shall be glad to see some of my old friends if only for a day, for I am not at all sure of not being sent to some other place directly I arrive at home.

Believe me ever yours, and write, as our affairs are uncertain.

Castle,
Capetown.
December 13*th*, 1845.

John Cowley, Esq., Winslow, Bucks.

My Dear Sir,

I had a box containing Bulbs and Seeds indigenous to the Cape forwarded to you for acceptance as a small Memorial of my unchanged regard for you, and which I trust may, under your care flourish, as everything else does. I have taken every pains to have them of the rarest and most beautiful kinds, and sincerely trust they may give you pleasure and repay your trouble in cultivating them.

We are now daily expecting our relief, and I soon hope to have the pleasure of seeing you again.

I wrote to George about a week since, and as letters sometimes miscarry, think it necessary to inform you, giving the direction and address.

This has been a very cool summer until just now. The heat to-day is about 95 in the shade.

The Crops in the neighbourhood of the Cape are very good, plenty of rain having fallen. Fruits of all kinds are just coming in, Plums, Apricots, Loquots, Guavas, etc.

I often think of you and my old friends at Winslow. I see a good deal of Adam Baynes, who is here in the Customs Department.

We are anxiously looking out for news from Buenos Ayres, and hope we may be sent there. Nothing would please me better than seeing some service that I might be able to say I had really seen men's pluck tried, and our own fine fellows under fire. I think the Old *Inniskilliners* would astonish the South Americans.

I have been labouring under a severe cold for some weeks, but I hope now to get quit of it.

I am, My Dear Sir,
Ever faithfully and sincerely,
W. N. Irwin.

(*To be continued.*)

Current Literature.

HUFF, N. L. **Algæ in Water Supplies.** *J. Amer. Water Works Ass.*, 1926, v. 15, 496-504. Also in *Public Works.* New York. 1926, v. 57, 256-9.

Algæ are minute forms of plant life found wherever natural waters are exposed to light. They are the ultimate source of food for the fish and animal life of pond and stream. A plankton net or a fine sand filter will separate countless millions of these minute organisms from the clear water of a deep lake, but it is in small lakes and reservoirs and in sluggish streams where light is abundant and summer temperature high that over-production of algæ is most conspicuous.

Algæ in excessive number are apt to impart colour, taste and odour to water and may be injurious to health. Descriptions of tastes and odours are rather vague, and attempts to classify them as effects of different algal growths have not been very successful. One must distinguish also between the effects due to living algæ and to the same in a state of disintegration.

The algæ most troublesome in water supplies fall naturally into two large groups, the *green algæ* (Chlorophyceæ), and the *blue-green algæ* (Cyanophyceæ). Of these, the former group, which is less objectionable, may be divided into three sub-groups. The first, a unicellular and colonial form, bright green in colour, imparts a green colour to the water and usually floats near the surface though it seldom forms scum. The second is a group including filamentous forms, which clings to stones or water weeds or forms masses of filthy-looking scum. Sometimes the oxygen given off by the algæ under the influence of sunlight may buoy the mass up to the surface by day, to sink again at night as the gas gradually gets away. The third sub-group of green algæ comprises the diatoms. They seldom form scum and are mostly found where the water is disturbed by wind, etc. Usually their green colour is obscured by a brown pigment so that the water is rendered turbid and unfit for laundry work or paper making on account of the stains produced. They also impart a fishy odour to the water. The second large group, the blue-green algæ, form exceedingly delicate and fragile cells, which multiply at an enormous rate and the mortality is correspondingly high. Some forms emit a " pig-pen " odour when growing, but generally the odours are intensified with death and disintegration and may become exceedingly offensive.

The most effective method of destroying algæ is by use of copper sulphate, which may be added to lakes and reservoirs by dissolving the crystals from coarse sacks towed behind boats. Where the algæ are mainly concentrated in a scum, surface treatment by spraying with copper sulphate solution may be more satisfactory.

As to the amount of copper sulphate required, no rule can be given. Identification of the form causing trouble and knowledge of its habits and

life history must be the guide. Trouble due to diatoms is not always curable by use of copper sulphate; all the blue-green forms are sensitive to it, and with these the main thing is not to delay treatment until they multiply unduly and leave much matter to disintegrate.

In all places where trouble with algæ is common, the water should be examined daily with the microscope by someone who understands algæ. Any tendency for a growth to develop can then be checked at once by a suitable application of copper sulphate. [As an addendum to Professor Huff's interesting article, the following quotation is relevant:—

"These algal troubles may, it is true, be combated or even overcome by the use of copper sulphate (dose 2 to 10 lb. per million gallons), but such treatment should never be undertaken in the absence of skilled supervision and responsible advice.

"As a last resort in the writer's experience the objectionable taste of waters tainted as a result of algal growths can, *in certain cases*, be effectually removed by the addition of minute doses of permanganate of potassium to the water as it passes into supply. The dose naturally varies with the oxidizability of the particular water, but speaking of the London water supply the innocuous dose of about 2·5 to 5 lb. of permanganate per million gallons of water was found to destroy the taste within a few minutes. . . Here, again, such treatment is only admissible in special circumstances and when placed under the vigilant control of competent advisers."—(Houston —*Studies in Water Supply*).] GUY T. P. TATHAM.

Reprinted from "Bulletin of Hygiene," Vol. 1, *No.* 11.

TAYLOR, W. A. **Hydrogen Ion Concentration—Its Meaning and Its Application.** *Water Works.* Chicago, 1926, v. 65. 15-20, 3 figs.

The electrometric method for the determination of hydrogen ion concentration requires elaborate equipment and therefore the colorimetric method is the one used in water works practice. The standards of the latter method are prepared from acids and alkalies with the addition of a salt of a weak acid, such as potassium hydrogen phosphate, sodium hydrogen citrate, the presence of which causes the hydrogen ion concentration of the mixture to change only slowly during the addition of further acid or alkali. Substances with this action are known as "buffers." A series of standards is prepared from these buffered solutions, differing in hydrogen ion concentration by pH 0·2; a little of an indicator which reacts over the corresponding range of pH values is added, and the tubes containing the series are hermetically sealed. The colours are permanent for about a year, kept cool and in the dark.

Hydrogen ion concentration has been made use of in a large number of industries. In water purification it is of importance in the softening process, in control of coagulation, in the prevention of corrosion in the distributing system, in bacteriological work and in co-ordination of the various steps of the process to give increased efficiency.

Coagulation by alum takes place at a definite pH value, which is affected by colour, turbidity, natural alkalinity, temperature, etc. This value and the amount of coagulent required can be determined in the laboratory. A definite amount of alum solution is added to several portions of a fixed volume of the water to be treated, and varying amounts of sodium carbonate added. The hydrogen ion concentration of each portion is then determined and the pH value of the portion in which the best and quickest flocculation occurs is taken as the optimum pH value. A second test is made, changing the amount of alum used. In this way the best amounts of alum and alkali which give the best flocculation in the shortest time, and the optimum pH value are determined. All that is then necessary is to see that the water during treatment possesses this pH value. If the water contains natural alkali sufficient to react with the alum, the use of sodium carbonate in the test is unnecessary. Coagulation at the optimum reaction means that the maximum efficiency is obtained from the chemicals used, without any waste.

The use of alum increases the corrosive properties of a water and it may be necessary to add alkali after filtration. This again can be controlled by means of the pH value.

A method is described for the determination of the reaction of the bacteriological culture media used in a water works laboratory, in which a loopful only of the medium is placed in a small cell on an opal plate, diluted with water, and the indicator added. Quantities of buffered standards are placed in similar cells, the indicator added, and the colours compared with that given by the medium. J. H. JOHNSTON.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 8.

DELAPORTE, A. V. and MANUEL, F. R. **The Action of Alum in Filtration.** *Water Works.* Chicago. 1926, v. 65, 154-6. [6 refs.]

When an alum solution is first added to a water, no change is immediately visible; then a faint opalescence is observed, followed by a flocculent precipitate which settles out, leaving the supernatant liquid clear and free from the disperse phase. The term "disperse phase" is the expression used to denote the suspension of minute particles constituting a colloidal solution, the medium in which the particles are suspended, in this case water, being termed the "dispersion medium." The disperse phase carries a negative electric charge, which is neutralized by the positive charge on the aluminium ion, with the result that aggregation of the colloidal particles takes place and they become large enough to settle out.

The mechanism of the reaction is conveniently divided into two parts, the first being the action of the dissociated aluminium sulphate, which is split into aluminium ions holding three positive charges and sulphate ions holding two negative charges. The trivalent aluminium ion effects the precipitation of the negatively charged disperse phase. In the second part

of the mechanism of the reaction there is the formation of the aluminium hydroxide or flock. This itself is a colloidal action. The hydroxide forms first as infinitesimally small particles which soon increase through a range of sizes until the visible flock makes its appearance and the settling action sets in. A visible flock is essential when alum is used as a precipitant in sedimentation basins, and such quantity of alum must be added as to bring the water to the "iso-electric point," the point at which the positive electric charge on the alum added equals the negative electric charge on the colloidal matter in the water.

The alum flock has a strong surface action and removes from the water colouring matter, organic matter and bacteria. It removes also a proportion of the sulphate ions, and if carbonates are present it removes the carbonate ion. This process of removal by surface action is known as "adsorption."

J. H. Johnston.

Reprinted from "Bulletin of Hygiene," Vol. 1, No. 8.

Reviews.

Barrier Charts for Health Officers. Second Edition. By S. H. Daukes, O.B.E., M.B., etc. Wellcome Bureau of Scientific Research. London: Baillière, Tindall & Cox. Wallet of 4 charts. Price 2s. 6d. net.

The designer of these charts is well-known to the Royal Army Medical Corps as the officer of the Territorial Force, R.A.M.C., who, during the war, had charge of the Army School of Sanitation at Leeds, a description of which is given in the first volume on Hygiene in the Official Medical History of the War. Dr. Daukes is now the director of the Wellcome Bureau of Scientific Research, and these charts are published on its behalf. The subjects of the four charts are the alimentary group of infections, including cholera, typhoid, dysentery, undulant fever, and infections by intestinal parasites; the group of infections caused by inoculation of diseases by insects, mainly tropical diseases; the respiratory group of infections, in which the author includes small-pox, chicken-pox, pulmonary tuberculosis and pneumonic plague amongst other diseases, attributed to infection by the respiratory tract; and the contact group of infections, such as scabies, venereal diseases, leprosy, tetanus, anthrax, erysipelas, puerperal fever, rabies, trachoma and other less common diseases.

Whatever view we may take of the author's system of grouping diseases for the purpose of his barrier charts, the practical result is an admirable and clear exposition of the causes of the various diseases, their incubation period, the period of infectivity, the preventive measures to be constructed as barriers against invasion of the infection, the effect of the infection passing a barrier, and the fresh barriers that must be constructed, stage by stage, throughout the course of the disease. All these factors and barriers

are exhibited in parallel columns, with the text of the barriers in red lettering. The general design and character of the charts are excellent, and should prove invaluable not only for instructional purposes but also for all those engaged in sanitary work, or seeking knowledge on the subject of preventive diseases and how to combat them.

DIETS FOR BOYS DURING THE SCHOOL AGE: REPORT TO THE MEDICAL RESEARCH COUNCIL. By H. C. Corry Mann, O.B.E., M.D. Published by H.M. Stationery Office. Price 2s. 6d. net.

A report of a most interesting research has recently been published by the Medical Research Council. This is on "Diets for Boys during School Age," by H. C. Corry Mann, O.B.E., M.D. The research consisted of watching the progress as regards height and weight of groups of boys all of whom received a basic diet to which was added in the case of each group a substance the effect of which, on height and growth, was the subject of investigation. Other factors concerned were the same throughout, as the work was carried out in an institute receiving boys where housing conditions were excellent and the sick-rate low. The experiments were conducted over a period of four years. This period allowed of a good average being obtained, and eliminated exceptional growth which might have occurred during a shorter period. Records were made of the actual quantities consumed at the meals. It may be said that all the experiments appear to have been controlled with the greatest care and attention to detail. The basic diet varied from: 1,679 to 2,154 calories daily, providing 37·3 calories per pound of body weight for a boy of 45 pounds, and 35·9 calories per pound of body weight for a boy of sixty pounds. It contained 56 to 71 grammes of protein, 29 to 47 grammes of fat, and 288 to 347 grammes of carbohydrate daily.

The basic diet was evidently adequate in that sixty-one boys gained an average of 3·85 pounds per boy, and grew an average 1·84 inches per boy in twelve months. The interesting point, however, is the effect observed on this rate of growth in each group to which some addition was made. The outstanding increase was in the milk group; forty-one boys received in addition to the basic diet a ration of fresh cow's milk, pasteurized homogenized one pint (388 calories daily), and gained an average of 6·98 pounds per boy, and grew an average of 2·63 inches per boy during twelve months.

The other groups were as follows compared with the milk group:—

Group	Number in group	Equivalent calories	Increase in weight	Increase in height
(1) Basic diet	61	—	3·85 lb.	1·84 in.
(2) Milk	41	388	6·98 ,,	2·63 ,,
(3) Caster sugar ..	20	350	4·93 ,,	1·94 ,,
(4) Butter	26	387	6·30 ,,	2·22 ,,
(5) Margarine	16	379	5·21 ,,	1·84 ,,
(6) Casein	30	65	4·01 ,,	1·76 ,,
(7) Watercress.. ..	26	—	5·42 ,,	1·70 ,,

The only conclusion drawn is that the improvement following the addition of certain substances to a diet adequate from a physiological standpoint was most successful in the case of the fresh milk group.

It would appear, however, that when more light is thrown on the complex nature of the fat soluble vitamin, the real underlying factor which has produced these increases especially in the case of milk and butter will be more obvious.

As a side issue it is brought out that the milk group boys showed far more "spirit" than those of the other group. It is clear from this illuminating report that those engaged in the "Drink More Milk" campaign are working along sound lines. D. G. C.

WHEELER'S HANDBOOK OF MEDICINE. By William R. Jack, B.Sc., M.D., F.R.F.P.S.G. Eighth Edition. Edinburgh: E. and S. Livingstone. 1927. Pp. 630. Price 12s. 6d.

For many years Wheeler's handbook has had an established reputation among medical students as a guide to clinical work in the wards and as a "cram" book for rapidly refreshing the memory when the day of the final examination draws near. The book will be helpful as an introduction to the more extensive revision of medical knowledge which is necessary for Majors, R.A.M.C., undergoing the course for promotion at the Royal Army Medical College, and when on service abroad, where larger textbooks are not always within reach, this small manual will be found most convenient when the reader has occasion to "look up a case" in a hurry.

The book was first published in 1894, and it has since run through many reprints and eight editions. The new edition differs from its predecessors only in being more complete and up to date and in containing brief but practical accounts of those advances in diagnosis and treatment which have been introduced in recent years.

In the descriptions of medical diseases the reviewer has rarely found so much information conveyed so lucidly and in so few words. The section on nervous diseases is particularly clear in the way it is arranged and written, and its lucidity is enhanced by many excellent diagrams.

We know of no more useful medical vade-mecum for the doctor to carry in his kit-bag during his travels abroad, and we commend the book to our readers.

HIGH BLOOD-PRESSURE: ITS VARIATIONS AND CONTROL. By J. F. Halls Dally, M.A., M.D., etc. Second Edition. London: Heinemann. 1926. Pp xvi + 196, with 30 illustrations. Price 12s. 6d. net.

The first edition of Dr. Halls Dally's volume on high blood-pressure was published in 1923, and there would have been an earlier issue of a second edition but for the destruction of the whole of the type by fire. The new edition includes the most recent work on high arterial pressure and the diseases of which it is a symptom. Generally speaking, it constitutes an attempt to indicate the position of sphygmomanometry in clinical medicine and at the same time assess both its advantages and limitations. The purpose of the author has been admirably achieved. There is a clear

description of the methods of clinical estimation of arterial pressure, the practical employment of the auditory method, and details of those mercurial and aneroid sphygmomanometers which the author recommends and those which should be avoided. Physiological and physical factors in blood-pressure and its physiological variations form subjects of two of the chapters. A chapter which clears up the relationship of the terms "hyperpiesis," "hyperpiesia," and "hypertonia," terms which are still somewhat loosely employed, will be welcomed. The author now classifies them on a basis of fundamental physical laws. Another chapter of special interest is one containing a series of observations on simultaneous tracheal pressures in pulmonary tuberculosis. Other chapters deal with arteriosclerosis, causation and significance of high arterial pressure, its symptoms, diagnosis and prognosis, and its control by psycho-therapy, diet, rest, exercise, massage, drugs and so on. A very brief statement by Dr. Fortescue Fox on treatment by baths and waters is appended to the chapter on control. Arterial pressure in relation to life assurance, and a history of the clinical estimation of arterial pressure by direct and indirect methods, with descriptions of various instruments, conclude the series. There is a bibliography of 209 references, together with a useful index. The illustrations are excellent and descriptions of the instruments employed exceptionally clear. The volume is one which the clinician cannot well do without, and we know of no other which deals with the subject of high blood-pressure so exhaustively and practically in so small and handy a form. Incidentally, it may be noted that the author regards the Baumanometer as the most generally applicable to consulting room, hospital or visiting work, and the auditory method as the quickest, simplest and most accurate yet devised for estimating arterial pressure.

BAILLIÈRE'S SYNTHETIC ANATOMY. By J. E. Cheeseman, Deputy Medical Officer of Health, Borough of Leyton. London: Baillière, Tindall and Cox. 1926. Price 2s. 6d. net each part.

This is a new and ingenious method of teaching or learning anatomy, and consists of a series of transparent and coloured plates which can be superimposed on one another so as to show *in situ* the soft tissues and structures from skin to bone, and from back to front or vice versa, for each part of the body separately. In a way it represents the dissection of the whole body. There are twelve parts altogether, but only three are so far ready, namely, the upper arm and shoulder, the forearm, and the hand. There is an author's introduction to each part, with a complete index, corresponding to reference numbers on the plates, of all the structures shown. Arteries are coloured red, veins blue, muscles brown, nerves yellow, tendons, ligaments, fascia, etc., green, and bones and other structures in black outline. Each of those parts already published contains twelve transparent plates, one half showing the structures from skin to bone and on the reverse side from bone to skin. The parts are kept together in a filing case, from which each part can be easily detached and

its plates studied separately. Each plate, as it is turned over, reveals the structures immediately underneath, or several plates can be held against the light, superimposed, and the structures of the part looked through in depth. Altogether an extremely handy and useful method of studying anatomy and refreshing one's memory before undertaking an operation. To the physician it will be found an excellent method of studying the origin, course, and distribution of the nerves of the different parts. We can strongly recommend the use of this synthetic anatomy to the R.A.M.C., and find the price extremely moderate when one takes into consideration the cost of colouring the structures in so many different colours.

Notice.

THE ROYAL SANITARY INSTITUTE—HENRY SAXON SNELL PRIZE.

The Henry Saxon Snell Prize was founded to encourage improvements in the construction or adaptation of sanitary appliances, and is to be awarded by the Council of the Royal Sanitary Institute at intervals of three years, the funds being provided by the legacy left by the late Henry Saxon Snell (Fellow of the Institute).

The Prize in the year 1927 will consist of Fifty Guineas and the Medal of the Institute, and is offered for an Essay on "Sanitary Accommodation, Appliances and Fittings, for Hotels and Flats, with suggestions as to proper placing, arrangement, ventilation and lighting, particularly where there are no external walls in which windows can be placed."

GENERAL CONDITIONS.

(1) The Essay to consist of not more than 5,000 words, to be typewritten on foolscap, one side only, and to be illustrated by drawings or sketches.

(2) Two Competitors may combine in sending in an Essay and Drawings.

(3) Essays must be delivered on or before September 30th, 1927, addressed to the Secretary of the Royal Sanitary Institute, 90, Buckingham Palace Road, London, S.W. 1, and the following points must be observed:—

(*a*) The Essays to be submitted without the name of the competitor.

(*b*) The Essays to bear a motto, legibly marked on the right hand lower angle of the first sheet.

(*c*) The Essay to be enclosed in an envelope, bearing the words "Henry Saxon Snell Prize," and the competitor's motto at the right hand lower angle, and to be directed to the Secretary of The Royal Sanitary Institute.

(*d*) The Essays to be accompanied by a letter containing the competitor's name and address, which is to be enclosed in a separate envelope sealed with a blank seal, and having on the outside "The Henry Saxon Snell Prize," and the same motto as that attached to the Essay submitted.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notified at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, Clinical and other Notes, and Echoes of the Past.

Any demand for *reprints, additional to the above*, or for excerpts must be forwarded at the time of submission of the article for publication.

Notices of Births, Marriages, and Deaths are inserted in the *Corps News*, free of charge to subscribers. All communications should be written upon one side of the paper only; they should by preference be typewritten; but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed: The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, S.W.1.

The Committee has sanctioned the publication of correspondence on matters of interest to the Corps, and of articles of a non-scientific character under a nom-de-plume. These communications must, however, be approved by the Editor before publication.

MANAGER'S NOTICES.

The JOURNAL OF THE ROYAL ARMY MEDICAL CORPS is published monthly, a volume commencing on 1st July and 1st January of each year.

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All subscribers to the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, whose annual subscription is paid direct to the Manager of the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, will receive monthly a copy of the *Corps News*.

The *Corps News*, separate from the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, can be subscribed for at the rate of 4s. per annum, including postage, payable in advance.

Subscriptions for the *Corps News* separate from the Journal cannot be accepted from Officers on the Active List unless they are also subscribing to the Journal.

The *Corps News* is not on public sale, but obtainable only from the Manager, JOURNAL OF THE ROYAL ARMY MEDICAL CORPS.

Cheques or Postal Orders should be made payable to the "Manager, Journal R.A.M.C." and crossed "Holt & Co."

All communications should be addressed to THE MANAGER, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," A.M.D.2, WAR OFFICE, WHITEHALL, S.W. 1.

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THE CHOLERA EPIDEMIC OF 1926 IN SHANGHAI WITH REFERENCE TO THE CLINICAL TREATMENT OF 368 CASES.

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FOREWORD.

THE following description of some clinical features of the epidemic of cholera which occurred amongst the civilian population of Shanghai during the summer months of 1926 is of interest at the present juncture.

The arrival in the area during the early part of this year of a considerable British defence force naturally focuses the attention of the Army medical authorities on the hygienic problems affecting the health of the troops. The Shanghai area, as is well known, is normally very densely populated, and the political situation is such that the civilian population is increasing in density month by month.

The defence force barracks are inevitably in proximity to congested areas of civilian population, and any medical problem in communicable disease which affects, or is likely to affect, the population generally is also

of prime importance to the Army. The whole of the force is situated within the International Settlement of Shanghai, an area of about eight and two-thirds square miles, with a Chinese population of about 800,000 and a foreign population of about 23,000. This district is surrounded by the French Concession to the south, the original Chinese city of Shanghai further south, the Chinese area of Paoshan and Chapei to the east and north, and the Chinese town of Pootung across the Huangpu River (see fig. 1). Within these surrounding areas there is an estimated population of about 1,410,000, but it must be appreciated that, since Shanghai lies at the most important point on the delta of the Yangtsze River, and towards it converges an immense network of creeks crowded with junks

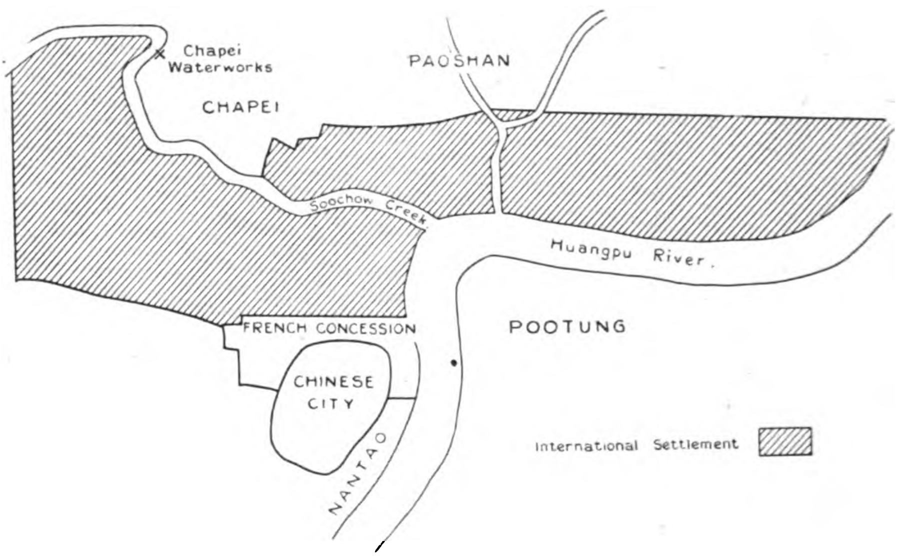

Fig. 1.—Plan of Shanghai. Showing the surrounding districts.

carrying produce to and from the interior, the floating population is an immense and variable factor.

Especially is this river population important with regard to the contamination of the water by the cargoes of fæcal material that are carried from Shanghai to the agricultural districts up river, and the lack of all sanitary arrangements upon the junks, since the river and creeks supply greater Shanghai with all water for drinking purposes, etc.

Even in times of epidemic cholera the foreign population is not seriously affected. This is due to various reasons, the chief of which is the good water supply of the International and French Concessions; added to this is the almost universal observance by the foreign inhabitants of a few simple rules regarding food and beverages which will be enumerated in the section dealing with the preventive aspect of the disease. It is, therefore,

not anticipated that the foreign troops will run any grave risk of a serious outbreak, as, naturally, the preventive aspect will be of prime importance to the Army officials on the spot. But, on account of the unsettled state of the interior, apart from the influx of refugees of British and other nationalities, there is a steadily increasing indigent Russian population, and most of the fifty-three confirmed cases of cholera among foreigners during 1926 were of this class. It remains to be seen how this variation in the community will affect the epidemiology of cholera in the ensuing hot weather.

SOURCES OF INFECTION.

Out of the total of 3,140 Chinese cases of cholera notified during the year, 1,165 were living in the International Settlement. The homes of all these were visited by the sanitary inspectors, and the following table is compiled from their reports :—

TABLE I.

(A) Contact with a previous case	20
(B) Water—contaminated	84
Native ice	122
(C) Food—contaminated, process unknown..	145
,, ,, fly infection	118
,, ,, infection from excreta	4
Melon—contaminated	236
Other fruits—contaminated	42
(D) Source of infection untraced	394
Total ..	1,165

The above figures give, at least, a general idea of the various sources of infection, though, with the difficulties that beset the work of the sanitary inspector in such a district, they cannot be perfectly accurate.

(*a*) *Contact with a Previous Case.*—Cholera was epidemic in the surrounding provinces of Anhwei, Chekiang, Fukien, Kiangsu, Kwantung and Honan, and infection was probably brought into Shanghai from these cases; but most of them would go to the Chinese areas outside the Settlement, and though treated in the Settlement and duly notified, the houses could not be visited.

(*b*) *Infected Water Supply.*—Whereas, as we have mentioned above, the waterworks supplying the International and French Concessions produce a pure and palatable water, unfortunately the same cannot be said about certain Chinese waterworks. The majority of cases among Chinese during the first half of the epidemic came from Chapei, a district supplied by the Chapei Waterworks, which are of comparatively recent construction, but were not maintained in a proper state of repair and efficiency. The intake was from the Soochow Creek, as shown on the map. Samples of water taken from the Chapei Waterworks at the end of July were found to contain the cholera vibrio, and, after the plant had been thoroughly cleansed and disinfected, the incidence of the disease immediately dropped, especially in the Chapei area.

Native ice is peculiar in that it is collected during the cold winter months from small creeks, and is stored in deep pits covered with straw, etc., until the warm weather comes. It is, therefore, exceedingly liable to harbour infection.

(*c*) *Contaminated Food.*—The coolie class purchase most of their food either from itinerant vendors or at shops where it is protected in no way from the dust and flies. During the hot season melons are a favourite fruit; these are sold already cut in slices, and frequently "freshened" by the hawker with a dirty cloth dipped in water containing native ice, and therefore quite probably contaminated by the cholera vibrio.

History.

The first case of cholera was notified at the end of May, but it was not until the beginning of July that the spread of infection became serious. During the month of July 1,417 Chinese cases were notified, and this is probably not half the number of actual cases. From the beginning of August the number of cases notified gradually decreased, until on November 3 the last notification was received, giving a total of 3,140 Chinese and 76 foreign cases notified during the year.

The mean degree of temperature during the summer was higher than had been recorded for fifty-six years. The readings from Siccawei Observatory for the months of May, June, July, August, September and October being 68·96°, 70·72°, 81·54°, 83·56°, 75·44°, and 61·08°, respectively.

The 3,140 Chinese cases that were notified to the municipal authorities received treatment in the various hospitals within the Settlement, some of which were special institutions for the treatment of summer diseases only. All the foreign cases were treated in the Municipal Foreign Isolation Hospital, but only about 10 per cent of the Chinese patients were treated at the Municipal Chinese Isolation Hospital on account of lack of accommodation, though the hospital remained full to capacity during the greater part of the time in question. These are the cases upon which we are reporting.

Diagnosis of the cases depended upon two factors:—

(1) Clinical: For details of which refer to the notes preceding Table III.

(2) Bacteriological: Laboratory diagnosis.

The bacteriological diagnosis of the cases under review was performed at the Central Laboratory at the commencement of the epidemic. Stools when sent there were subjected to a very careful and elaborate examination, and no case definitely given a positive finding which did not satisfy all the following criteria: (1) Growth of cholera vibrios after cultivation through a series of alkaline peptone water enrichment media; (2) growth on Dieudonné media of controlled "ripeness"; (3) agglutinability with standard homologous sera; (4) morphological characteristics of the vibrio conforming to certain standards.

The Central Laboratory during the epidemic also selected a series of cultures for absorption tests. When the epidemic assumed considerable proportions, the bacteriologists of the Central Laboratory confined their attention to work on sources of infection and a selected series of stool examinations. A rapid microscopical examination system was instituted in the Clinical Laboratory of the hospital.

The clinical diagnosis, as we have emphasized, guided all treatment of an emergency nature which was naturally instituted immediately a patient arrived in hospital. For the purposes of notification and case record the positive result of the stool examination by the direct microscopical method of stained films was taken as a necessary corollary.

Towards the end of the autumn, when the epidemic gradually subsided, the full bacteriological examination was reinstituted. This was valuable in connexion with the possibility of "carriers."

We were able to have convalescents' stools examined on two occasions by cultural methods for a negative report before we permitted them to leave hospital.

The cholera cases amongst foreigners which we record in this paper were all confirmed by full bacteriological examinations throughout the epidemic, and were retained in hospital until the stools were reported to be negative, so that no "carriers" were allowed to go out.

Treatment of 321 Chinese Cases.

From June 24 to November 2, the day on which the last case was admitted to the Chinese Isolation Hospital, 359 Chinese were received and notified as suffering with cholera. On subsequent investigation it was found that thirty-eight of these were suffering with other intestinal conditions, and they are not, therefore, included in this report.

The wards were arranged in three groups, each group being subdivided into male and female sections :—

(1) *Treatment.*

(2) *Semi-Convalescent*—to which patients were transferred as soon as possible, a state that occurred on the third day after admission, or later, and where the diet included congee (rice water) only, given three times a day.

(3) *Convalescent*—to which transfer occurred about the sixth day after admission, and where ordinary full hospital diet was given. In these, as in the semi-convalescent wards, in place of the usual hair mattresses, straw mats were placed on the metal bed frames, a procedure that was found to be most satisfactory in the hot weather.

The staff of the hospital consisted of :—

Two foreign doctors (R.C.R. and C.C.P.A.).

One resident Chinese doctor.

Six Chinese doctors, resident at other municipal isolation hospitals, who constituted an emergency team and took part-time duty in relays during each twenty-four hours.

Two foreign sisters, one in charge of the wards, and one in charge of the administrative and admission section.

A complement of Chinese nurses and coolies.

The following table gives the details as to the number of patients treated, sex, etc.; it should be noted that the cases grouped as "discharged uncured" were removed from hospital in various stages of recovery and collapse by their relatives against our advice, and no information was received as to their ultimate fate.

TABLE II.

	Cases treated	Discharged cured	Discharged uncured	eaths	Percentage of deaths
Men	254	220	6	28	11·02
Women	67	49	6	12	17·91
Total	321	269	12	40	12·45

On admission to the hospital each patient was examined and classified according to the severity of the symptoms—the degree of collapse, the state of the pulse (often not palpable), the blood-pressure, the frequency of defæcation and the type of stool. The following arbitrary groups were used, as shown in the table:—

TABLE III.

Condition on admission	Cases treated	Discharged cured	Discharged uncured	Deaths	Percentage of deaths
Very severe	61	28	4	29	47·54
Severe	146	131	7	8	5·48
Moderately severe ..	54	51	0	3	5·55
Moderate	60	59	1	0	0·00
Total	321	269	12	40	12·45

Most of the patients came from the coolie class, accustomed to scanty dietary and hard physical labour. The majority came within the age-groups 21 to 40, as the next table shows, and, as would be expected, the very young and the very old succumbed more readily.

TABLE IV.

Age group	Cases treated	Discharged cured	Discharged uncured	Deaths	Percentage of deaths
1-10	15	6	2	7	46·66
11-20	24	19	1	4	16·66
21-30	125	112	6	7	5·60
31-40	86	73	2	11	12·79
41-50	49	42	1	6	12·24
51-60	19	15	0	4	21·05
Over 60	3	2	0	1	33·33
	321	269	12	40	12·45

On admission, if the condition was not too severe, a hot bath was given first. The temperature, the pulse-rate and the blood-pressure (when possible) were recorded. A hypodermic injection of atropine, $\frac{1}{100}$ grain, was given next, and the intravenous transfusion with Rogers' hypertonic saline [1] (sodium chloride 120 grains, calcium chloride 4 grains, potassium chloride, 6 grains, water to one pint), at about the temperature of the rectum. The apparatus used is shown in fig. 2; an interesting feature was the glass bubble [2] (fig. 3) that showed the continual flow of saline into the vein. In a few cases only was it found necessary to make an incision over the

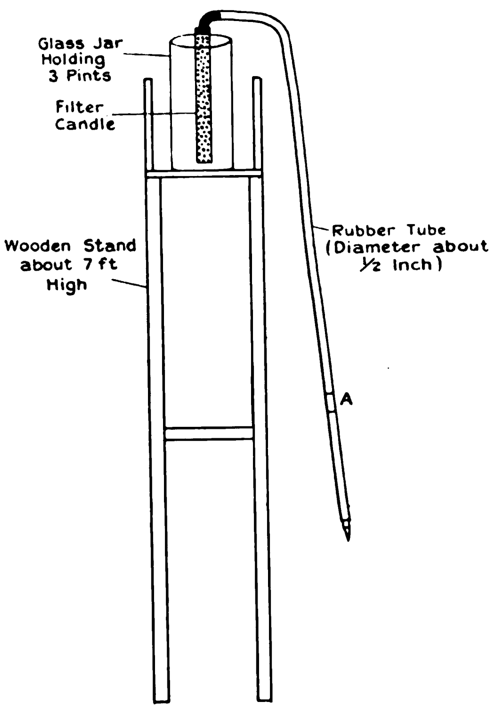

Fig. 2.—Transfusion Apparatus.

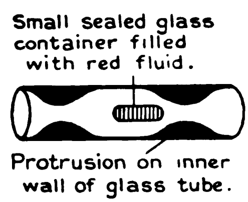

Fig. 3.—Glass tube at joint "A" in fig. 2. When the flow of saline is continuous the container falls to the bottom, otherwise it rises.

vein and to tie in a cannula, i.e., only in those cases where the collapse was so great that no sufficiently distended vein could be found.

Varying with the severity of the condition, two to fourteen pints of saline were given, transfusion being stopped as soon as the blood-pressure remained steadily above 100 millimetres Hg and the pulse was firm.

Retransfusion was carried out whenever the blood-pressure fell below 100 millimetres Hg, or the pulse showed signs of failing, and we found that even after two or more retransfusions (one man had thirty-eight pints in all and recovered) the chances of recovery were increased rather than lessened.

A solution of potassium permanganate (one to four grains in a pint of water) was given for drinking purposes to all cases, repeated sipping insisted upon, and continued until the stools began to form. No harmful symptoms were produced, and it seems likely that the toxicity of the substances absorbed through the intestines was thus reduced.

A 2 per cent solution of sodium bicarbonate was given to all patients to drink if examination of the urine showed the presence of either albumin or acetone—it was found feasible to mix the solution with the potassium permanganate solution in equal parts—and if symptoms of acidosis appeared, retransfusion with one pint of a stock alkali solution (℞ sodium chloride 1·5 per cent, sodium bicarbonate 4 per cent) together with three pints of Rogers' saline, was started immediately, and repeated if required.

In spite of repeated warnings against the use of opium in cholera, we gave morphia to certain cases, mostly opium takers, when the abdominal and limb pain was severe, and on no occasion was there cause for regret. Where vomiting was a troublesome condition, we found that mist. bismuthi. B.P.C. gave relief in almost every case within a few hours.

Tomb's essential oil treatment was not utilized for certain reasons, and, similarly, kaolin was not employed, since we wished to prove the value of Rogers' standard methods of treatment.

Deaths.—Forty cases died, and the complications that led to death in twenty-six of these were: Uræmia and "acidosis," 11; peritonitis, 5; pregnancy, 5; respiratory diseases, 4; pyæmia, 1.

The cases dying from peritonitis had all been "needled" before admission by native pseudo-doctors, who had pierced the abdominal wall with needles in the hope of thus curing the disease.

Only two pregnant women recovered; one aborted in the fifth month and the other was delivered of a still-born child during the treatment stage.

More than one-third of the fatal cases succumbed before they had been in the hospital for twelve hours, as will be seen from the following table, and most of these were moribund on arrival.

TABLE V.—LENGTH OF STAY IN HOSPITAL BEFORE DEATH.

Less than 12 hours	14
,, 24 ,,	7
,, 48 ,,	6
More than 48 ,,	13
	40

Deaths from Uræmia and "Acidosis."—Although no opportunity was available for determining the pH of the plasma in those patients who died, there were eleven deaths that followed the symptoms of clinical acidosis, i.e., in which there was marked acetonuria and air-hunger. Most of these cases were also associated with a gradual diminution of highly concentrated urine followed by anuria about twenty-four hours before death.

The urine of all cases was tested daily both for albumin and for acetone, and it was found that the former was present in about one-half of the cases almost from the beginning, while acetonuria (Rothera's test) was present in about one-third of the cases on or after the third day following admission. These acetone bodies may have been due to: (1) Physiological causes, such as starvation; (2) pathological causes, denoting the onset of "clinical acidosis."

Since the eleven cases that died with the symptoms mentioned above had a rapidly increasing amount of acetone in the urine, we felt that for purposes of treatment the second cause should be considered the most likely, and the results obtained by the transfusion of repeated single pints of alkali, together with the sodium bicarbonate solution by the mouth, tended to confirm our opinion. For, whereas before August 2 this treatment had not been carried out, and seven cases had died with symptoms of clinical acidosis, after that date forty-three cases out of 116 showed acetonuria that cleared up within a day or two of the first alkali transfusion, while of the four that died one was complicated by a bilateral pneumonia and another had been ill for eight days before admission and died within six hours.

We shall endeavour during the coming summer to find if this condition, that comes on not earlier than the fifth day after the onset of the disease, and is definitely relieved, if not cleared, by the addition of alkali to the plasma, is related to the state of uncompensated or true acidosis where the pH is abnormally low. Myers and Booher [3] have already shown that in nephritis there is not infrequently this condition of true acidosis, where the pH of the plasma may fall as low as 7·02, and the indications are that in cholera the toxin acts at a very early stage directly upon the renal tissue.

Rigors.—Some difficulty was experienced in a few cases during the transfusion, since they developed severe rigors suddenly and became extremely collapsed. This was not due to an alteration in the temperature of the saline, which entered the vein at the temperature of the rectum, but to a too rapid flow into the vein, since clamping the rubber tube to half its capacity, together with local applications of heat (blankets, bottles, etc.), was sufficient to produce a cessation of the symptoms.

Foreign Cases.—Seventy-three cases were admitted and notified as suffering with cholera, but only forty-seven of these were confirmed by bacteriological examination; the remaining twenty-six are, therefore, not included in the following tables. Of the 73 cases, 20 were Russians, 19 Japanese, 12 Indians, and 10 British.

TABLE VI.

	Cases treated	Cured	Deaths	Percentage of deaths
Men	35	30	5	14·28
Women	12	9	3	25·00
	47	39	8	17·02

Source of Infection among Foreign Cases.—Investigations were carried out by the sanitary inspectors with the following results :—

TABLE VII.

(A)	Contact with a positive case	1
(B)	Water—contaminated	1
	Native ice	3
(C)	Food—contaminated, process unknown	16
	,, ,, fly infection	9
	,, ,, infection by excreta	1
	Melon—contaminated	4
(D)	Source of infection unknown	12
	Total	47

It is therefore seen that infection of the food was the most important factor in the spread of the disease, and that the absence of adequate covering for food frequently led to that infection.

The high death-rate of 17·02 per cent was not due so much to the greater severity of the outbreak among foreigners, but rather that in most cases persons of the indigent classes of poor physique and stamina were attacked.

Conclusions.

(1) That, with adequate hygienic precautions, cholera should not affect the foreign population of Shanghai.

(2) That, when cases reach hospital in the early stages, cholera is no longer a very fatal disease.

(3) Uræmia and clinical acidosis were the most serious complications noted in this series of cases.

The thanks of the authors are due to the Commissioner of Public Health for the use of certain figures and tables, and to Mr. G. J. Turnbull for his notes on certain geographical and epidemiological data.

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APPRECIATION: A REVIEW IN TWO PARTS.

By Major A. C. AMY, D.S.O.
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I.—THE AGONY.

Appreciation is "the act of appreciating; valuation; a just valuation or estimate."

One of the tests in the examination of Majors, R.A.M.C., for promotion to the rank of Lieutenant-Colonel is described thus:—

"As the Senior Administrative Medical Officer of an Independent Force, writing an appreciation of a situation from its medical and hygienic aspects."

From the soldier's point of view an appreciation "is a military review of the actual situation culminating in a statement of the measures recommended to meet it"; and such an appreciation has to be written according to plan thus:—

"The writing of appreciations in the accepted logical sequence is a necessity. The general headings and the necessary sequence are:—

(i) Object.
(ii) Considerations which affect the attainment of this object.
(iii) Courses open to the two sides.
(iv) Plan."

Our appreciations must conform to this formula, for "to ensure mutual confidence and unity of action all training must be conducted on uniform lines."

This is awkward: the formula was never constructed for us; from our point of view it is cumbrous and, in certain aspects, meaningless.

What is suitable for the fighting troops is not always suitable for the medical service.

However, a special scheme for the writing of medical appreciations is never likely to find a place in regulations: for the sake of uniformity we must take things as they are and mould our appreciations accordingly.

The soldier knows that—1st, "War is the ultimate resource of policy, and every nation must be ready, in the last instance, to protect its vital interests by force of arms, unless it is prepared to surrender them to an enemy without a blow"; and, 2nd, "War can be brought to a successful conclusion only by the defeat of the enemy's armed forces and the destruction of his powers of resistance."

The whole life and training of a soldier, including the planning and writing of appreciations, are based on these two principles.

However, "military forces are primarily divided into two categories :—

(i) Fighting troops.

(ii) Services."

And, as "Fighting troops carry out the actual military operations, and (as) all their energies must be concentrated on that duty," it is clear that their whole alphabet, from A to Z, is included in the two principles quoted above.

Inasmuch as the Services are the handmaidens of the Fighting troops they, too, are governed by these two principles. But whereas these principles apply in a very special and particular manner to the Fighting troops, they only apply to the Services in a general way.

The truth of this is most evident in the case of such highly-specialized and technical corps as the Medical, Dental and Veterinary.

"The general functions of the medical service of the forces in the field are as follows: The preservation of the health of the troops; the professional treatment and care of sick and wounded; the replenishing of medical and surgical equipment; and the collection and evacuation of sick and wounded from the theatre of operations."

The Fighting troops are death-dealing.

The Medical Service is healing.

To differentiate in this way is neither strictly accurate, nor comprehensive; but it intensifies light and shade to such a degree that one is bound to admit that the Fighting troops and the Medical Service stand on different planes, and must have different angles of vision.

These conceptions are self-evident truths. They are matters of common knowledge. It would be impertinent to point them out to any Major, R.A.M.C., who is going up for his promotion examination.

But are they applied in practice?

No; they are not—in so far as the appreciation is concerned at any rate.

A Major, R.A.M.C., writes his appreciation as a death-dealer, and a poor one at that. The "G" member of the Board reads it either with indignation or dismay (never with amusement!) and says: "When I'm a General in the next war, I shall want someone to run my medical arrangements. *I'll* do the fighting."

It is sad to have to hurt a candidate's *amour propre*: it is sadder still to have to note that he has ignored the fact that a General has a staff which deals efficiently with matters which are not the concern of the A.D.M.S. at all.

If the A.D.M.S. burns his fingers at this fire, he deserves all he gets.

An A.D.M.S. who minds his own business has quite enough to do in doing that efficiently.

Not so very long ago a candidate handed in an appreciation which was made up as follows :—

Nine sections containing ninety-two sub-sections.

The sub-sections contained forty-two paragraphs and numerous sub-paras.

There were two appendices ; and the whole covered nineteen pages of typed foolscap.

This was supposed to have been written by a D.M.S. for the information of his G.O.C., at the close of heavy fighting and when further fighting was expected. Under these circumstances there would not have been sufficient time, opportunity or inclination to write, or to read, a mammoth production of this kind.

There would just have been time for the G.O.C. to obtain a new D.M.S.

It was an encyclopædic essay, a gigantic treatise : it was not a medical appreciation.

In this examination there were other "appreciations" of the same type. When the candidates were asked their reasons for perpetrating monumental works of this kind they put forward the following excuses :—

1st.—That the occasion was a promotion examination : that it was not, in fact, active service.

2nd.—That the articles, &c., which appear from time to time in the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS had been taken as models.

Lack of Imagination.

A glance at the regulations for the examination of Majors, R.A.M.C., will show that the examination is based on practical lines.

It is devised to test the candidates' professional fitness for service in the field.

Apply this to the appreciation in question : obviously it is intended to be of practical value to someone who is waging war.

The recipient of this appreciation is NOT the Examining Board : the "G" member of the Board reads the appreciation as if he were the G.O.C.-in-C. in charge of the situation dealt with by the candidate. The latter is, for the time being, the representative of "M" attached to the G.O.C.'s staff.

If candidates could bring themselves to realize this from the outset, a big element of error would be eliminated.

The fact that there are "M" members on the Board who assist "G" to assess the value of the appreciations does not affect the argument.

Subordination to Fashion.

What we may call "staff articles" (for want of a better term) in the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS must be read with caution and discrimination.

These articles are most carefully thought out and worked out, but :—

(*a*) They embody the personal opinions and experiences of their writers. They are not necessarily authoritative even in a demi-official sense.

Incidentally, this remark also applies to this article !

(*b*) The fashion of yesterday is not the fashion of to-day, and it will not be the fashion of to-morrow.

"Staff" articles should be read and weighed accordingly ; and, in writing a Medical Appreciation, avoid the bizarre.

We are told that the Medical Service should take over one quarter of the work now done by "G" ; half of "A's" present job ; and three-quarters of the duties of "Q." Beware !

We also read that the Medical Service should drive its own motor transport. "Join the B.M.A. *and* the Owner-Drivers' Union !" is the latest slogan.

It has not yet been suggested that we should fly our own aeroplane-ambulances ; no doubt the suggestion will appear in print before long and, when it does, let us hope that the author of it will be appointed first pilot at an early date. The sooner he is disposed of the better.

By all means let us look ahead but, unless you follow the profession of Mr. H. G. Wells, no good can be derived from looking a thousand years ahead.

It is all very pleasant, and stimulating, and diverting; but were I a Major, R.A.M.C., on promotion examination bent . . .

In a different category, accounts of Medical Staff Rides—"Medical," mark you—are a potential source of danger. They provide us with dissertations on the meteorological characteristics of Surrey, Hants and Berks ; conjectures on contours ; elaborate march tables ; the ranges of guns of every calibre, and so forth. All very interesting and instructive ; *c'est spirituel, mais ce n'est pas la guerre.*

The present fashionable tendency to labour the military side at the expense of the medical does harm to the prospects of candidates for promotion.

Every thoughtful officer of the Corps—unless he is going up for the Majors' promotion examination—knows that when the soldier comes first, and the doctor second, the result is disaster. That is an old, old story, but periodically it is forgotten.

II.—THE ART.

There are two kinds of appreciations :—

A. "Those in connexion with subjects elaborated in peace time, such as plans of campaign."

B. "Appreciations of minor strategical or tactical problems in the field."

The latter are those with which Majors, R.A.M.C., have to deal.

Note the words "*in the field.*"

Before writing his appreciation a candidate, as S.A.M.O. of an Independent Force, should first of all:—

(1) Consider the time and place and—in a general way—the circumstances.

(2) Define his position *vis-à-vis* the recipient of the appreciation.

(3) Remember the functions of the Medical Service in war.

(4) Breathe in the atmosphere of active service.

The appreciation should be brief, precise, and deal with essentials only.

It should be written in the continuous glare of two penetrating and pitiless searchlights of criticism. They are:—

(*a*) This piece of information is within my special knowledge. Should it be made known to the recipient?

(*b*) Within my special knowledge this measure is good and practicable. Should it be recommended to the recipient?

If you have information which is already in the possession of your G.O.C., or which cannot benefit him, keep it to yourself.

As a rule candidates are successful in telling G.H.Q. (i.e. the Board) what G.H.Q. want to know; but they are infinitely more successful in telling of things which G.H.Q. do not want to know; and unfortunately the former class of information is swamped by the latter.

The following, culled from examination papers, are examples of items which a G.O.C.-in-C. does not require—and, indeed, does not wish—his D.M.S. to appreciate:—

The detailed composition of the whole force in accordance with W.E.'s.

An estimate of the enemy's strength.

A detailed description of the dispositions of all the units of the Force.

A discussion of the policy and intentions of the G.O.C.-in-C. of the Force.

A long description of the topography of the scene of operations.

A learned monograph headed "Prevalent Diseases."

A scientific note entitled "Classes of Wounds."

A commentary on the various methods in use for estimating casualties due to sickness and wounds.

Pages and pages about medical units and arrangements, which are discussed from every possible standpoint.

Cui bono? Cave quid dicis, quando, et cui.

Because our angle of vision is not the same as that of the Fighting troops, and because we are specialists, therefore do we require a method of constructing and compiling our appreciations which will conform firstly, to our particular functions; and secondly, to the recipient's understanding.

The plan which follows is put forward by way of suggestion. It is not

a "model" because it is not complete; it is, admittedly, open to improvement; and, if it calls forth criticism, so much the better.

(i) *Object.*—See "general functions of the Medical Service" already quoted.

In the appreciation these functions should be dealt with in their order of importance in the situation which is being appreciated—that is, not necessarily in the order in which they are set down in F.S.R.

(ii) *Considerations which affect the Attainment of this Object.*—Or, considerations which affect the various functions of the Medical Service in the situation now under appreciation.

(iii) *Courses open to the two Sides*:—

(*a*) A statement of the different courses of action open to our own Medical Service [not including the subject-matter under "(iv)" below.]

(*b*) A note regarding enemy action of a kind likely to affect our own Medical Service's functions.

(iv) *Plan.*—The present plan; plans to meet contingencies; measures recommended.

Again—appreciation of these plans or measures should be confined strictly to the medical situation under review.

All that remains now is to apply the above to a concrete case, thus:—

General and Special Ideas, and a Narrative were issued to the candidates. The paraphrase which follows was not, of course, issued; but if, in similar circumstances, candidates would exercise a little imagination and make such a paraphrase, they would be able to visualize war conditions, and thereby render their appreciations more practical and realistic than they now are.

Arcady is attacked by Avernus.

Utopia—an Overseas Dominion of the Arcadian Commonwealth—sends an Expeditionary Force to the aid of Arcady.

This E.F. consists of an Army of two Corps, each of three Divisions; it also has a Cavalry Division and Tank, Armoured Car and Air Force units; and the usual L. of C. and Base units and formations.

The S.A.M.O., Utopian E.F., is a D.M.S. In addition to his Divisional and Corps medical units he is fairly well supplied with the usual L. of C. and Base medical units.

Utopia's disembarkation is complete by 20.00 hours on 7th October.

On the morning of 8th October, Utopia's advanced elements, viz., 1st Division (I Corps) and 4th Division (II Corps) 1st Cavalry Brigade, and a company of Armoured Cars are attacked on Arcadian soil by an Avernal force which is greatly superior in numbers and guns.

The battle lasts until 20.00 hours on 10th October. The Utopian line is pushed back from two to four miles; the losses have been very severe.

Heavy casualties have been inflicted on the Avernal troops; but, as the enemy's strength is estimated at twelve Divisions disposed in depth, it is expected that he will renew the offensive within a short time.

Utopia's 1st Cavalry Brigade and Armoured Cars are withdrawn; and, by 21.00 hours on 10th October, the 2nd Division (I Corps) and 5th Division (II Corps) begin to relieve the 1st and 4th Divisions.

The concentration, disposition and plans of the Utopian E.F. are such that, if the enemy can be held in check until 14th October all may—and probably will—be well; but if, before that date, Avernus gains a decisive success, the position of the U.E.F. will be serious.

The situation is discussed at a conference held at Utopian G.H.Q. on the night of 10th October. So far the G.O.C.-in-C. has had little time or opportunity for thinking of matters medical; but after the conference the D.M.S. is told to summarize[1] the medical story of events up to 00.01 hours on 11th October.

G.O.C.-in-C. will see D.M.S. at 09.00 hours on 11th October.

N.B.—(*a*) We are in the midst of active and severe hostilities.

The appreciation has to be written during a quiet interval of uncertain —and probably short—duration.

(*b*) The G.O.C.-in-C. has no time to waste in reading a thesis; the D.M.S. is too busy to write one.

BRITISH W.E.'s.

APPRECIATION[2] OF THE MEDICAL-SANITARY SITUATION, U.E.F.

BY D.M.S., U.E.F.,

FOR THE INFORMATION OF G.O.C.-IN-C., U.E.F.

Arcadian Survey Sheet No. 1.	Scale ¼ inch to 1 mile.	
,, ,, ,, ,, 101.	,, 1 ,, 1 ,,	
,, ,, ,, ,, 102.	,, 1 ,, 1 ,,	

G.H.Q., U.E.F.,
00.01 hrs. on 11th Oct., 1926.

[1] The actual question ran thus:—
"As D.M.S. of the Utopian Force on 11th October, write a General Appreciation of the Medical-Sanitary Situation for the information of the G.O.C.-in-C. of the Force."

[2] The numbers (i) (ii) (iii) and (iv) in the appreciation correspond to the same numbers in A.O. 117—1926; Training and Manœuvre Regulations, 1923, Amendment. Section 25, page 45, para. 4.

A.—*Collection and Evacuation of Sick and Wounded.*

(I.)

Present distribution of all In-Patient Casualties, U.E.F.:—

Collecting Zone—				
Field Ambulances, etc.	485			
Evacuating Zone—				
Casualty Clearing Stations, etc. ...	4,312			
Distributing Zone—				
General Hospitals, etc.	1,113			
Transferred Overseas to Utopia ...	1,000			
	6,910	{	Officers ...	146
			Other ranks ...	6,764
Died in Medical Units, U.E.F....				1,019
U.E.F. Medical Units are also dealing with:—				
Arcadian Civilian Patients...				107
Avernal Ps. of W., S. and W.				88

(II.)

Collecting Zone.—There is a dearth of stretchers and blankets.

Evacuating Zone.—Motor Ambulance Transport has been impeded by shelling and aerial bombing.

Distributing Zone.—All General Hospitals are not yet functioning.

This has caused (*a*) severe congestion in Evacuating Zone; (*b*) premature transfer overseas of 1,000 patients.

(III.)

(*a*) It may become necessary to work the Motor Ambulance Transport at full pressure. At present this is undesirable owing to intensive shelling and bombing in the day-time.

It may also become necessary to evacuate direct from Ambulance Trains to Hospital Ships.

(*b*) Should enemy action result in a heavy influx of casualties:—

(1) Within twenty-four hours the medical situation will be grave.

(2) Within twenty-four to thirty-six hours the medical situation will be serious.

(3) Within thirty-six to forty-eight hours the medical situation will be fair.

(4) After forty-eight hours the medical situation will be good.

(IV.)

Collecting Zone.—An adequate supply of stretchers and blankets is being hurried to the front.

Evacuating Zone.—Road Traffic Control is directing Motor Ambulance Transport along those secondary roads which are least subjected to fire.

Distributing Zone.—The remaining General Hospitals are opening rapidly. Convalescent Depôts are being expanded.

Recommended that a warning notice be issued to D. of S. and T. G.H.Q., to the effect that it may become necessary to make fuller use of returning R.A.S.C. transport for the evacuation of "light" W. and S.

B.—*Treatment and Care of Sick and Wounded.*

(I.)

	W.	S.	Infections	Transferred overseas	Died in medical units
Officers, U.E.F.	125	1	—	20	41
O.Rs., ,, ...	5,017	202	17	980	1,496
Civilians	27	40	31	—	9
Ps. of W.	81	1	—	—	6

(II.)

Seriously wounded, and gas-shell casualties, are unusually high.

Personnel, R.A.M.C., 1st and 4th Division, and 1st Cavalry Brigade have sustained heavy casualties—30 per cent of strength.

(III.)

(*a*) Courses open to U.E.F. Medical Service.—No remarks.

(*b*) See para. (III) (*b*) under section A above.

(IV.)

Surgical situation is in hand; but the teams cannot cope with the present amount of work indefinitely, and without assistance. The medical officer personnel, Utopian R.C.S. and Order of St. John, now assembling at the Bases, may have to be sent into the evacuating zone as a temporary measure.

Gas and infectious medical units have been detailed, and are functioning satisfactorily.

Recommended: (1) That the despatch from Utopia of reinforcements of R.A.M.C., all ranks, to form—for the time being—a 10 per cent reserve for the U.E.F., be speeded up. (2) That the despatch of V.A. Dets. of all classes be speeded up: their services are urgently needed now.

C.—*Preservation of Health.*

(I.)

Water Supplies.—Except at G.H.Q. and the Bases these are from wells, mostly shallow.

Baths and Laundries.—Except at G.H.Q. and the Bases, these are, for practical purposes, non-existent.

Small-pox.—During the first nine months of 1926 the incidence of this disease amongst civilians was :—

(1) In I Corps Area . . . 100 cases.

(2) In II ,, ,, . . . 30 cases.

At present there are no other remarks to be made under "Health."

(II.)

Water.—Dangers and difficulties are accentuated by: (1) Sudden influx of large numbers of troops and animals, and of refugees from the area invaded by Avernus. (2) Destruction of, or damage to, village wells by intense gun-fire.

Baths and Laundries.—Flight and (or) evacuation of civil population have accentuated difficulties in making temporary arrangements for baths and laundries in forward areas.

Small-pox.—Vaccination states:—

Of U.E.F. . . . good . . . 95 per cent protected.
Of Arcadian Army . . . fair . . . 80 per cent protected.
Of Avernal Army . . . uncertain . . . supposed to be 80 per cent protected.
Of Arcadian civilians . . . bad . . . 65 per cent protected.

(III.)

(*a*) It may be necessary to consider the advisability of forming a mobile Water Tank Service by motor, rail and barge.

The establishment of a similar Mobile Bath-Laundry Service might be considered.

Plans are being prepared for dealing with small-pox on a big scale.

(*b*) Enemy action is affecting water supplies, and also the small-pox situation. See remarks under C (II) above.

(IV.)

	Present measures	Remarks	Recommendations
Water	Chlorination	"Clearing" prior to chlorination is usually necessary	The attention of all ranks should be drawn to the importance of the water question
Baths and laundries	*Nil*	Early action is advisable	Equipment and manning under U.E.F. arrangements
Small-pox	Isolation	Early action is advisable as soon as conditions permit	Compulsory vaccination of all "unprotected"

D.—*Replenishment of Medical and Surgical Equipment.*

(I.)

There is a temporary shortage of small-pox vaccine and anti-tetanic serum. Otherwise, the position is good.

(II.)

Re vaccine. See heading "C" above.

Re serum. Practically all casualties have been inflicted on highly-cultivated soil.

(III.)

(*a*) and (*b*).—No remarks.

(IV.)

Supplies of vaccine and serum have been received on loan from the medical authorities of the Arcadian Army. Further supplies are being sent from Utopia. It is expected that they will arrive within seventy-two hours, and that they will be ample.

(Sd.) "X.Y.Z."
Major-General, D.M.S., U.E.F.

This appreciation covers less than four pages of typed foolscap, instead of nineteen. It brings out the salient points of the medical-sanitary situation at a given time and place. If it contains statements or figures which the General does not understand, he will ask his D.M.S. to explain or to amplify. In this respect he acts towards his D.M.S. as the members of a Board of Examiners act towards the candidates.

In an examination paper, better say too little than too much.

However, THE feature of the foregoing appreciation lies in the fact that Major-General X.Y.Z. has stuck to his own technical sphere throughout. He has resisted the allurements of banners, bugles and bayonets. By so resisting, he has put his General in possession of facts which the latter did not, but should, know; and which he (the General) is able to digest without feeling angry, or even irritated. That's something.

Let candidates practise the Art of writing Appreciations, and thereby spare the Boards the agony of reading them.

———

NOTES ON THE MEDICAL SERVICES IN THE FIELD.

By Lieutenant-Colonel T. S. DUDDING.
Royal Army Medical Corps.

(Continued from p. 266.)

PART II.

The Casualty Clearing Station.

[For much of the material for these notes I am indebted to Lieutenant-Colonel A. C. H. Gray, O.B.E., R.A.M.C.]

This field unit has been described as the pivot upon which the whole system of evacuation revolves. It is the collecting house for a wide area of the front line and the centre from which the casualties thus collected are distributed to rest stations and to the various L. of C. and base hospitals. Formerly dependent on outside sources for their transport, C.C.S.'s are now partially mobile, and when working together they combine for short distances if given sufficient time. Ordinarily they are allotted transport by "Q" Branch of the A.H.Q. when required to take up a new position. One C.C.S. is mobilized for each Division of an army, i.e., three per Corps of three Divisions. Nominally Army Headquarters control the movements of C.C.S.'s, though usually D.D.M.S. Corps supervises their employment and administration. C.C.S.'s are generally arranged to work in pairs or, if casualties are likely to be very heavy, in groups of three. Their functions generally are threefold, viz., (*a*) the reception and treatment of the seriously sick and wounded from the field ambulances until they are fit for further transport; (*b*) the further treatment and rapid evacuation of cases fit to travel, and (*c*) the treatment and retention in the Army area of the slighter cases. For the performance of these they may be divided into three corresponding sections; (*a*) Hospital section, (*b*) Evacuation section, and (*c*) Convalescent section, and to these must be added a primary section embracing the three, viz., that of reception.

The composition of the unit is such that it can officially deal with 200 sick and wounded, 50 in beds and 150 on stretchers, though in actual practice in the Great War it had at times to accommodate four or five times this number. The establishment consists of 12 officers, including a quartermaster, a dental officer and three chaplains, two W.O.'s and 81 other ranks, of whom 74 are R.A.M.C. In war establishments nursing sisters are not allowed for a C.C.S., nor do any join until it is engaged in actual operations; but when a C.C.S. is opened up and more or less settled, seven nursing sisters, Q.A.I.M.N.S., are dispatched to join it as its normal allotment. When the numbers of casualties coming in are great, the services of the dental officer and chaplains should be made use of when they are not engaged in their normal avocations. They can be of great

assistance, for example, in the reception room or evacuation section, where they can be put in charge of definite tasks. The dental officer may be rapidly trained as an anæsthetist, thus relieving a M.O.

The equipment of a C.C.S. is liberal and requires forty three-ton lorries, supplied by "Q" Branch A.H.Q., to move it in one journey, but generally a smaller number of lorries are supplied and the journeys repeated. During the Great War the size of the units so increased as to make them too unwieldy. In 1917 a scale of equipment was laid down which allowed of a Hospital section of 200 beds and a Convalescent section for 800 patients. Such a unit was supposed to be able to move forward rapidly; the 200-bedded section forming a nucleus. But the whole C.C.S. requires transport up to 200 three-ton lorry loads for its removal, the exact number depending on the amount of extra equipment drawn to make it as much like a hospital as possible whilst retaining its character of a more or less mobile unit. It is to be noted that the French H.O.E. (1) (Hospital of Evacuation) which corresponds more or less with our C.C.S. is a unit of 1,500 to 2,500 beds, but its hospital section is greater in proportion, being arranged to deal with 500 to 1,500 cases, whilst for the evacuating section the authorized number is 1,000.

Profiting by the experience of the War, the C.C.S. is now divided into a heavy section and a light section. The latter is the more rapidly mobile one, and is pushed forward when orders are received for a move to open up an advanced operating centre. It forms a nucleus round which the heavy section eventually gathers when it has been able to dispose of its sick and wounded, either by transfer to another C.C.S. of its group or to rest stations, or by evacuation to an advanced convalescent depot or to hospitals on the L. of C. It may take over a M.D.S. of a field ambulance with all its cases, if the site is suitable and large enough for the whole unit. It is capable of being moved in nine, or not more than ten three-ton lorry loads. Now under the new scale of equipment and transport each C.C.S. is provided with two three-ton lorries. These form the nucleus of the transport for the removal of the light section, the remainder, if required, being furnished by "Q" Branch of A.H.Q. But with three C.C.S.'s working in a group, the combination of their transport gives six lorries, which makes it possible to move the greater part of a light section in one journey without assistance from "Q," and therefore with greater independence at a time when all available spare transport is being utilized for the forward movement of troops, supplies and equipment. A more rapid establishment of a C.C.S. in the forward area and earlier provision of operating facilities for the wounded are therefore made possible by the inclusion of these two lorries as unit transport. As the equipment includes complete tented accommodation for the casualties, both marquees and bell tents, a certain portion of these accompany the light section for use in case buildings are not available or are insufficient.

This division into sections for purposes of movement is somewhat

analogous to a field ambulance with its advanced dressing party and its main dressing station, or possibly more so to the two companies of an A.D.S., one of which can be rapidly moved to open up a forward A.D.S. until it can be joined by the other which remains to dispose of its contained casualties and until no longer required in its old position. In the grouping of C.C.S.'s together the same system can be adopted when the need for forward movement takes place, one closing down to be pushed forward and the other (or others) remaining behind to deal with in-coming casualties until the sphere of activities is established in the new centre, when it (or they) in its turn closes and goes forward to complete the new grouping. It has also been found good practice to have one or more C.C.S.'s sited at some distance further back in the Corps area for dealing with the more serious cases which it is not advisable to evacuate further for some days, and in order to place them in a position of greater quietude and lesser liability to further removal in the event of enemy pressure. With this in view the C.C.S.'s are placed in two positions, (*a*) a forward one up to seven or nine miles from the front line, and (*b*) a back one some fourteen to sixteen miles in rear of the front line. With three units employed in an offensive two would be located in the forward area and one in the back, whilst in defensive operations the reverse would be adopted. When two or more are working together during active operations it has been found generally more convenient for one to be "on duty" at a time, and to remain so (with certain time limitations) until it has taken in 150 to 200 cases, when the M.A.C.'s are instructed to switch over the evacuation to the next C.C.S. for duty. This gives everyone an opportunity of finishing with one batch and clearing up before another is due, instead of having a never-ending chain of admissions. In easier times it may be more convenient to be "on duty" for twelve or twenty-four-hourly periods.

Different methods have been adopted on occasions for the distribution of casualties to C.C.S.'s which may be earmarked individually for "taking in," (*a*) on a geographical basis, i.e., from fixed sections or areas of the front, (*b*) according to Corps, or (*c*) according to the nature and locality of the wounds, e.g., head, chest, fractured thigh, abdomen, severely wounded, gassed, nervous, sick and infectious cases; or the last-named method may be combined with the first or second. During some of the largest battles in the Great War ten C.C.S.'s expanded to 1,000 beds each were required to deal with the casualties. These expansions were rendered possible by reinforcements from field ambulances, other C.C.S.'s from areas not actually engaged, and from general hospitals. Further help was given by the detailing of Labour Corps men, permanent base men and convalescent venereal cases, fifty of whom were very necessary for unloading and loading ambulance cars and trains. The medical unit reinforcements were usually surgical teams consisting of 1 surgeon, 1 anæsthetist, 1 sister, and 1 operating-room attendant, each team bringing its own equipment of portable table, instruments, dressings, gowns, towels, etc. The base

medical stores kept ready twelve sets of surgical team equipment available for issue on emergency, and the Red Cross stores packed sets of gowns, towels, etc., to correspond.

An important duty of the C.C.S. during active operations is to send to the field ambulance, by means of returning M.A.C. cars, stretchers, blankets, splints, hot-water bottles, etc., to replace or supplement those sent down by them. Reserve stocks of such articles are therefore maintained in C.C.S.'s and replenished from reserves brought up in ambulance trains or kept at A.H.Q.

It is useful to consider some of the conditions and requirements of modern warfare which affect a C.C.S. and its development, and compare them with those of a unit of pre-war times. The nature of the wounds has altered, formerly mostly clean-cut bullet wounds, now eighty-five per cent at least are shell wounds, ragged and infected with soiled clothing (i.e., in warfare against an enemy equipped with modern armaments). The numbers of the casualties are considerably greater, and the proportion of wounded to sick considerably higher, at any rate in European warfare, though the introduction of gas warfare has made a great difference. The rate of admission, previously slow and at long intervals, has become much more rapid through the reception of large batches at one time. The large increase in the number of cases of shock requires arrangements to be made for their treatment and resuscitation; stoves for warming purposes are an essential part of the equipment. Operative treatment, formerly deferred till arrival at a L. of C. hospital, is now considered essential to be carried out within twelve hours in at least thirty per cent of the cases. In fact, the needs of the wounded man may be considered to be the supply of organized transport to bring him to (and evacuate him from) the C.C.S., the services of a sound surgeon for thorough examination and treatment within six to twelve hours of being wounded, and the use of an operating table for twenty minutes to half an hour. The treatment of wounds has kept altering from time to time the methods to be adopted. Simple dressings have been followed in their turn by periods when incisions, pastes, salt packs, débridement, Carrel-Dakin irrigation and primary suture each had its advocates.

The frequency of infection by tetanus has necessitated the giving of A.T.S. to all wounded men, and the occurrence of gas gangrene has introduced fresh lines of treatment. X-rays have become essential and pathological work is pushed forward to the C.C.S. instead of being restricted to the base. Increased nursing facilities have been created by the introduction of sisters, and along with them has come the greater comfort of the patients, brought about by an increase in the equipment, such as floor boards in tents, stretchers, trestle-beds and mattresses to lie on, sheets and pyjamas, and laundry arrangements for cleanliness and comfort. Further, the introduction of aerial warfare has created the necessity for protective measures being adopted in the shape of digging, sand-bagging and light

control at night. The advent of the M.A.C. and the use of light railways has materially altered the system, both of admission and evacuation. The previous method of evacuation of medical units by the supply services had many objections, amongst which were the unsuitability of the vehicles for the transport of wounded, with consequent high degree of discomfort and danger, the failure to regulate speed to their requirements, the undesirability of conveying infectious cases, the difficulties in cleaning and disinfecting the vehicles again before using them for the carriage of supplies, the frequency of the changes in the meeting points, and the difficulties in keeping and conforming to the exact time-table required by the R.A.S.C.

Site.—In choosing a site for a C.C.S. there are certain desirable and undesirable characteristics which must be taken into consideration. It should have reasonable security from artillery fire, be close to a railway, and preferably on a railway siding, which can be used by ambulance trains for loading purposes, or be placed so that a siding and loading platform can be constructed in the unit's precincts. It is preferable to take the railway siding to a good site than to accept a bad one because it happens to have a siding on the spot. Stress is laid on the importance of easy access to a railway, and to obtain this it is better to choose a place some 6, 10 or 15 miles in rear of the M.D.S., if the roads between are good, if ample M.A.C. transport is available, and if the road traffic is well organized so as to prevent delays in transit. There must be good road approaches for vehicles coming from and returning to the front, with separate entrances and exits to avoid any blockage of transport, and with room for a number of cars to stand off the main roadway whilst waiting loading or unloading. There must likewise be ready access towards the rear. The area must be very roomy to allow of expansion for ease of working, increase of accommodation and protection from aerial bombing. An open space outside is preferable to one in the centre of the town, where roads are narrow and congested, movements cramped, expansion often impossible and liability to bombing and shelling much greater, but which, on the other hand, has usually a good water supply and drainage, the former of which at any rate is a necessity, though the latter can be improvised. It is well to avoid the vicinity of Supply Railhead and dumps of stores of any description. But these are rarely to be avoided if existing suitable railway sites are chosen, and further it is not an infrequent occurrence for a dump to appear close by *after* a C.C.S. has been established already on a previously satisfactory spot.

It will be seen from the above that tented or hutted accommodation in an open space on the outskirts of a town, with construction to it of a siding for ambulance trains, will give the best results. (In estimating the area required a knowledge of the accommodation capacity of types of tents and huts is valuable; these are: small marquee, 8 beds or 12 stretchers; large marquee, 14 beds or 20 stretchers; Nissen ward hut, 24 beds or 28

stretchers; Adrian hut, 40 beds or 60 stretchers; and Bessoneau tent, 40 beds.)

Lay out of Plan.—In planning the lay out of his C.C.S. the O.C. should have an exact idea in his mind of all requirements, probable and possible, and make allowance both for those that will become prominent later as

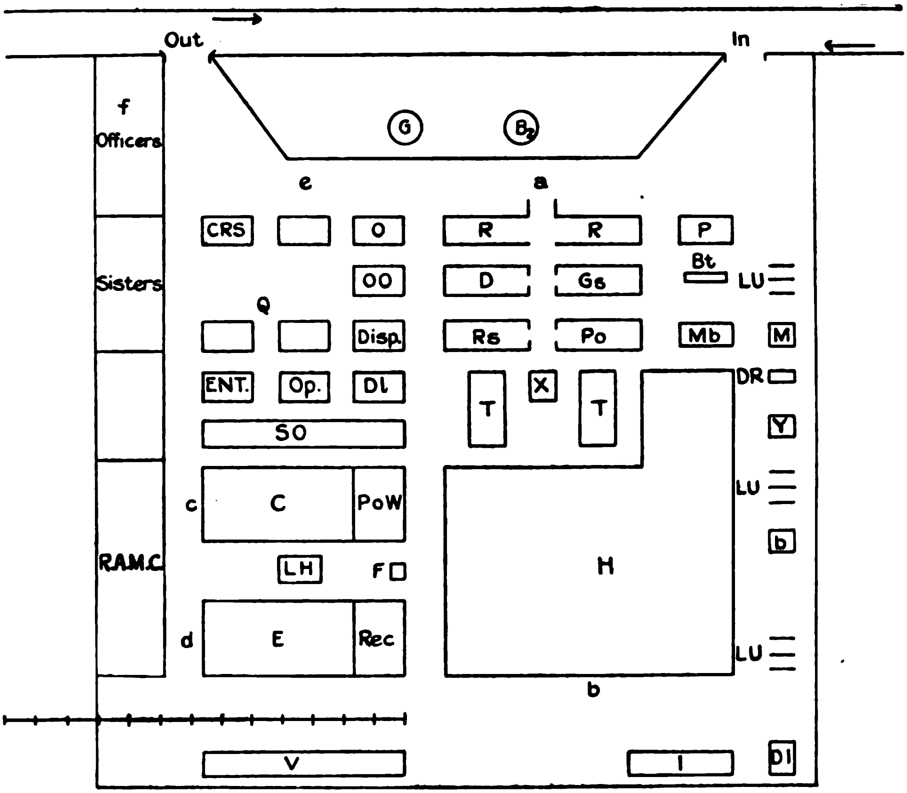

Diagram of Casualty Clearing Station.

a, Reception; *b*, Hospital; *c*, Convalescent; *d*, Evacuation; *e*, Administration: *f*, Staff; B2, Bearers: Bt, Baths; C, Convalescent; CH, Cook house; CRS, Car stores; D, Dressings; DL, Dental; DI. Disinfector; Disp., Dispensary; DR, Destructor; E, Evacuation; ENT, Ear, Nose and Throat; F, Fire alarm; G, Guard; Gs, Gas; H, Hospital; I, Infectious; LU, Latrine; M, Mortuary; Mb, Moribund; O, Offices; OO, Orderly Officer; Op, Eyes; Po, Pre-operation; P, Pack store; PoW, Prisoners of War; Q, Quartermaster's stores; Rs, Resuscitation; RR, Reception; SO, Officers' wards: T, Operating theatre; X, X-ray; Y, Laundry.

well as for those that must be met at once. And for this reason plenty of space must be allowed for expansion and development of any one particular section. But it often happens that a large unit gradually develops from and gathers round a small nucleus, in which case the siting is apt to be awkward, lacking in that good disposition which is so necessary for rapid and easy working and the prevention of clogging. The locality, nature

and limitation of the site frequently compel the O.C. to make important modifications in his plan, and a lay out that would be suitable on one site is frequently impossible on another. And further, different O.C.'s will have different ideas with regard to details. It follows, therefore, that no hard and fast plan can be adhered to, but all the arrangements are based on the principles evolved from the unit's functions aforementioned. In the attached diagram are to be seen the main details of a lay out, which can be altered according to circumstances.

The unit should be divided into different blocks or sections according to their functions: (*a*) Reception, (*b*) Hospital, (*c*) Convalescent, (*d*) Evacuation, (*e*) Administrative, and (*f*) Staff.

(*a*) Reception Section.

The work of this section includes much more than the name implies, as in it is carried out all the initial and much of the later actual surgical work of the unit. It would therefore be better termed a "Reception and Treatment Section," since to the reception room proper are attached the operation, resuscitation and dressing rooms, theatres, X-ray rooms and gas section, as well as the necessary adjuncts of administration section work required for recording, feeding, and kit storing. The smooth running of the whole is dependent on the good organization of the work in each section, as the work of one interweaves with the work of the next one. The continuation of an even flow of patients is to be aimed at. The more important details of the work of the subdivisions will now be dealt with.

The approach to the reception section from the main road for ambulance cars must be clear and roomy and capable of holding a number of cars if they come in large batches, whilst waiting for the unloading of the first ones, so that no blockage of the main road shall occur. There must be a separate entrance and exit, so marked on the gateways as to be visible day and night by in-coming vehicles. After unloading the cars should pass out at once after picking up their replacement stretchers, blankets and water bottles for return to the field ambulances, and after obtaining hot drinks for the drivers if their work is continuous. The actual unloading places at the reception room entrance or entrances should be under the cover of a porch, so as to prevent lights being seen from the air at night, and a white line should be made across the road, on which the drivers should stop their front wheels in the most suitable position for unloading. The reception room itself should be capacious and capable of accommodating at least the maximum number that may be brought at one time by the M.A.C. Ordinarily it should have one entrance and one exit only in use, with emergency exits for use if required. But if the rush is great, a second entrance should be arranged so as to expedite unloading. It should be divided into lying and sitting portions by light barriers, trestles for stretchers or four-foot tables being provided for the former, and seats for four with arm rests for the latter.

Special accommodation is provided for the gassed. Sanitary accommodation must be ample and bed pans and urinals provided for lying cases. Good warming and lighting arrangements are essential. The staff required is: (1) the unloading party of twelve or more stretcher bearers with a bugler to announce the near approach of cars and an N.C.O. in command entrance duties, who directs the removal of casualties to the proper area at the reception room, combs out any that should not have come (stragglers picked up on the road are frequent intruders), brings to immediate notice serious cases, those with tourniquets and the shocked, sees that the cars are emptied of all kits before leaving, directs the drivers to replenish their Thomas splints and bars, hot-water bottles, blankets, stretchers and pillows, and to obtain food if required and to return at once, and who sees that the roadway is kept clear; and (2) the reception-room staff, consisting of 1 M.O., 1 padre to assist, 2 sisters, 4 clerks, 4 pack store N.C.O.'s and men and 12 stretcher-bearers. The medical officer in charge is the hub of the system; he must be highly capable, experienced and rapid in his work of "triaging" the casualties, i.e., dividing them into their categories of: (*a*) sick, (*b*) gassed, and (*c*) wounded. Each of these three classes must be further triaged into: (1) convalescent (2) hospital, and (3) evacuation. He examines all the field medical cards and, with the aid of coloured pencils and different coloured labels, he allots each man to his special category and subdivision, and hence to his special destination in the hospital, the lightly wounded to the waiting and dressing-rooms, self-inflicted wounds to the S.I. wards, the more seriously wounded to the pre-operation or resuscitation wards, the gassed to the gas section, the sick to their general or their special wards, such as N.Y.D., nervous, venereal, infectious, etc., and P. of War, officers, and the obviously moribund to the wards detailed for them.

The clerks carry out the recording, by examining the field medical cards, filling up the foil and counterfoil of W.3210, affixing the former to the patient and sending the latter to the A and D book clerk; the packstore N.C.O. and his staff take over and label rifles and equipment, etc. Such articles as rifles, revolvers, watches and range finders should be specified; rifles will be unloaded, bombs and ammunition collected for return to Ordnance, haversacks being searched for bombs and ammunition. Valuables will be placed in small kit bags and secured. The man keeps his boots, respirator and cap. Gas-infected clothing is noted and dealt with at once. Prisoners of war are searched. Arrangements are made in the reception-room for the administration of A.T.S. if necessary, and the affixing of the C.C.S. indicating stamp. Emergency dressings are applied if required and stimulants are given to those needing them. The adjustment of tourniquets and the application of forceps for hæmostases also form part of the reception room duties, as well as the administration of morphia and oxygen when needed. The hospital cooks arrange for a plenteous supply of hot, nourishing drinks and refreshments, and cigarettes are available for those wanting them.

For walking and lightly wounded cases, which come in lorry loads from

the W.W.C.P., a separate entrance and reception area is frequently arranged. These pay for expectant treatment and the best that can be given them, as their period of incapacity will then be short and they can return early to their units. Their requirements are a waiting-room with arrangements for bathing, cleansing of clothing, feeding, X-raying, efficient surgical treatment, and a few days' retention in the convalescent section and rest station.

In the Gassed subsection accommodation must be very airy, with open sides; personnel must be provided with protective rubber gloves and overalls for the handling of infected clothing, the immediate removal and treatment of which is essential; special bathing facilities made for cleansing the patients, of whom the very slight and the very serious should not be evacuated; and surgical treatment given to the wounded and those requiring operation.

In the Pre-operation ward the man's clothing is removed and he is thoroughly cleansed, wrapped in clean, warm blankets and taken in his turn to the X-ray room and theatre (his clothing is put into a bag and labelled and sent to the pack store, if he is admitted to hospital), and he is supplied with hospital clothing; but he retains his boots, respirator, cap and small kit-bag.

The Resuscitation ward personnel must be thoroughly trained in their work. The stretcher trestle beds must be fitted with frames and palliasses and folding blankets to enclose warm air from the heating stoves or electric light bulbs if electricity is laid on. Supplies of preserved blood and six per cent gum solution must be ready for transfusion. If blood donors are available they should have been tested and labelled beforehand. Other necessaries will be stimulants, pituitrin, and rectal injection equipment.

The theatre (or theatres) should lead off from the passage going to the Pre-operation ward. It should consist preferably of a large well-lighted hut, divided up into operating cubicles, each fitted with a table and all the requirements for the work of a surgical team. If they can be arranged, two tables per team save much time, and it is considered that a maximum of eight teams is the most one unit can employ with advantage. A sufficient number of bearers are needed to bring in fresh cases and to remove them after operation to their wards in order to keep the flow continuous. Seats outside the theatre should be provided for them. A plentiful supply of water is essential, as are also large receptacles for waste water and dressings, etc. The windows must be fitted with blinds to prevent light escaping at night and the night lighting must consist of electric or good acetylene lights and boat lights fitted with covers for use when necessary. A N.C.O. is necessary to take particulars and make notes for entry on the field medical cards. The senior surgeon is in charge of the whole, and the senior sister controls the theatre arrangements. A plentiful supply of air is required without reducing the temperature too greatly; when several teams are working the air gets hot and heavy with the odour of anæsthe-

tics. A combination of ethyl chloride five parts, chloroform one part, and ether twenty-four parts, has been found a rapid and safe anæsthetic. Head and abdominal cases are attended to as early as possible, and in the latter class the operation to have a chance of success must be done within ten hours, and the man's pulse-rate be not above 120. It must be remembered that abdominal cases take a long time and therefore must not interfere with the treatment of other cases which could be dealt with in greater numbers. They must not be allotted to slow and unaccustomed workers, but a rapid, experienced operator should be told off for the work and a period of not more than thirty minutes allowed for each case. The surgeon in charge of the Pre-operation ward must decide on the advisability or otherwise of sending the cases in for operation. X-ray work is carried out *pari passu* with the operative work, as required by the surgeons.

(*b*) HOSPITAL SECTION.

The functions of this section are more in evidence during the times when military operations are not at the period of their maximum intensity and the numbers of casualties are not so great as to demand immediate evacuation of practically all. In such times many of the less serious cases as well as the most serious ones that cannot be or are better not removed are kept for recovery in the area, or until they are so far recovered that transportation will not be harmful to them. According to the size of the C.C.S. the hospital section is divided into its medical and surgical sides with their various wards for different classes of cases, and it has all the necessary arrangements of a hospital modified according to the amenities available.

Specialization of Cases.—On some occasions it has been decided to make use of the grouping of C.C.S.'s to send certain types of cases to certain C.C.S.'s only; but the separation of these at the field ambulances and in the M.A.C.'s gives rise to a good deal of additional administrative work which is not feasible in times of great pressure. But in the C.C.S. it is possible to arrange them in classes for hospital treatment, and this facilitates the process of evacuation when certain classes of cases may be required to be evacuated to special medical units in the area or hospitals of the L. of C. Separation into the following groups is generally carried out, viz.: (*a*) Sick, (*b*) wounded, and (*c*) gassed, with their subdivisions of serious and light, distinguishing walking wounded, heads, abdomens, fractured femurs, self-inflicted, N.Y.D. nervous, N.Y.D. gassed, mental, infectious, dysentery, cholera, etc. Officers and prisoners of war each receive separate accommodation. Gas gangrene commencing in any case in a ward and generally detected by the smell is the signal for its immediate removal to an isolation ward for such cases and the flushing of the ward with air. From the point of view of the ambulance trains, it is much more convenient and rapid to take a trainload of mixed cases to one hospital which has complete in itself all the different sections than to have to make

a tour of several hospitals to drop its different types of cases, thus causing considerable delay and frequently errors in sorting out.

Annexes serving both this section and the other sections are latrines and urinals, baths, disinfector, destructor, and mortuary. Recreation, writing, and dining tents should if possible be arranged for the convalescents during times of lesser activity. The gassed section has its own special arrangements for bathing and for dealing with gassed clothing.

(*c*) Convalescent Section.

This section is a compromise between the hospital and evacuation sections and affords shelters for those cases that can be returned to their units at once or within one or two days, or *transferred* to the Divisional Rest Station. A considerable number of cases of this class are apt to get down periodically, especially during rushes and when W.W.C.P.'s are established, and it is very necessary that such cases should be saved for the fighting line and not evacuated. The accommodation provided need not therefore be so elaborate as for the hospital section but sufficient to indicate that hospital treatment is being given them.

(*d*) Evacuation Section.

This section deals with patients on: (*a*) Discharge; (*b*) transfer to rest stations in the area; (*c*) evacuation to L. of C. From whichever section of the C.C.S. the casualties come they will each be marked with its distinctive label (*a*), (*b*), or (*c*), initialled by the M.O.'s selecting them and again checked by the officer in charge of the evacuation section.

It should be capacious and roomy and have separate compartments for the above three classes, with any subdivision considered necessary. The third class requires the most room during times of stress. The main functions of the section are to provide shelter, rest and food for cases after treatment whilst awaiting their turn to be taken from the C.C.S., and to facilitate arrangements for the actual removal, and for the recording of the cures. Cases from the hospital and convalescent sections pass through it, only just prior to removal, for record purposes and for collection. When removal is by M.A.C. there should be plenty of room for the manœuvring of the cars and for loading purposes. The whole process must be so arranged that it is entirely separated from and causes no interference with the work of admission which is going on at the same time. A definite staff is detailed for it, and all details should be so fixed that there is no delay in getting away the casualties at the time fixed by the O.C. M.A.C. in the case of removal by cars and by the R.T.O. for removal by ambulance train, or by the A.P.M. for discharges. No man must leave the exit door or enter a vehicle without being checked and entered on the roll. There may probably be difficulty in the disposal of men discharged to duty, as frequently divisions have left the area. Instructions must be obtained

from Army or Corps Headquarters as to what to do with them, but usually they are handed over to the A.P.M., who collects them. in parties for despatch to their respective areas. Every man on discharge must be carefully inspected to see that he moves off properly turned out, clean and smart, with his own rifle and kit complete, including his valuables, box respirator, and rations for any period that may have been previously specified. Complaints must be noted and investigated. If everything is correct, he should sign a pack store book that he has received all belongings. The man must leave in a contented frame of mind.

Venereal cases must have their special treatment cards, and should be seen by the A.P.M. to elicit information as regards source of infection. Self-inflicted wound cases must only be disposed of under special instructions received from Headquarters, and must have their cards properly marked and filled in and be accompanied by any necessary documents. Accidental wounds should be accompanied by the statements of witnesses.

The importance of having a railway siding in the compound which obviates the necessity for the aid of the M.A.C. cannot be over estimated as a factor in providing great comfort for the patients, facility in working and economy in time and personnel. If not on the line itself the laying of a light railway to an ambulance train platform in the lines of the C.C.S. may possibly be arranged through "Q" Branch of the Army.

The C.C.S. organization for evacuation must be well organized to avoid confusion and delay. A special officer and staff accustomed to the work are detailed for it. On the platform are an emergency dressing room, refreshments and sanitary annexes, with if possible cover, and warm shelter for the worst cases at any rate. The Officer Commanding himself examines each man and his field medical card as he goes on to the platform. It is surprising how often a convalescent or other case not for evacuation gets included amongst them. Each man brings his box respirator and any X-ray plates or special documents for transfer, e.g., in connexion with mental, infectious, S.I., etc., cases. Very serious and moribund cases should not be sent. Chest wounds, abdominal cases and complicated fractures go down on their own stretchers. In the case of fractures extreme abduction of the limb should be avoided as being unsuitable for loading. A light meal should be given before starting, but where food is scarce at the front it must be remembered that the ambulance train is equipped with food and can easily get replenishments at the base. When possible each man must sign a book that he has no complaints and has got all his personal belongings. In the case of officers and their kits this is most important, and each officer should sign his kit inventory and the counterfoil be retained in the C.C.S. The cases on arrival on the platform, each with his evacuation ticket, are sent to the specially allotted areas for (*a*) officers, (*b*) sisters, or (*c*) other ranks, and then divided into lying and sitting cases. Special classes such as infectious, mental and V.D. cases are kept to their respective loading points opposite the coaches. The train

must be ready in the siding, and with the O.C. liaison should have been opened up as regards loading arrangements. The worst cases and the lying are entrained first so as to give them the best accommodation and lower berths for easier attention. But no loading is to be commenced without the permission of the O.C. train, or his representative. Each man is checked by a nominal roll before entraining, and his evacuation ticket removed for checking purposes. A system of numbered tickets corresponding to the numbers on the evacuation roll is a considerable help.

(*e*) Administration Section.

Here are all the offices, including those of the O.C. and the clerks, and also the dispensary and quartermaster's stores. The clerks' office should not be too far away from the reception room, as all the necessary information for completing the A and D book and for making out the necessary returns and reports for periodic despatch have to be continually brought here; and similarly also particulars of discharges and evacuation must be recorded.

The Quartermaster controls the feeding arrangements and arranges for the supplies of food, dressings, splints, medicines, blankets, hot-water bottles, fuel, etc., to meet the needs of the sections, and replenishes them from supply depots, advance depot medical stores, medical dumps and ambulance trains. Blankets and stretchers and hot-water bottles accumulate in the sections unless they are regularly gathered together and brought into store. He sees that the ambulance car replenishment store is kept well stocked with such necessary articles as are required by the field ambulances as replacements or additional supplies, and keeps a supply of petrol, oil and water in case the cars run short; and for the drivers he arranges food and hot drinks as they have to carry on for many hours without being able to get back to their unit headquarters.

The general feeding arrangements for the different sections form a most important part of his duties. One main cookhouse is established, with the necessary personnel for distributing the food, but a subsidiary one is usually necessary in connexion with the reception section. The Quartermaster must always keep in stock additional rations and be prepared for rushes. Needless to say his supervision of the sanitation must be very strict, and ample arrangements made for the removal of excreta, dressings and waste food, etc., which rapidly accumulate when large numbers are being dealt with, and for the washing of soiled clothing, blankets and bandages. Fat saving, too, comes within the scope of his duties, and he must make the utmost endeavours to prevent waste of every description, as the C.C.S. is a wasteful unit. Amongst these efforts may be numbered the exhibition of food-saving mottoes, the washing of bandages, recovery of soda from tins, the keeping of pigs and chickens to meet emergencies when the unit is more stationary, and the loading of ambulance trains before meal times and as soon as possible. A frequent inspection of what is being burnt in the incinerator will show whether wastage is going on.

When orders for the transfer of the unit to another place arrive, applications for transport must be put in at once to A.H.Q., who order the move, and also for a loading party if additional men are not locally available. If the move is by train, thirty trucks with coaches and wagons for personnel and their baggage are necessary. End- and side-loading trucks for vehicles and the Thresh are necessary. Closed wagons for the stores are preferable, to prevent losses and to protect from weather. The usual orders to the personnel as regards sitting on steps, leaving the train, straying off at halts, and giving others lifts should be strictly observed

On arrival at its destination unloading should be proceeded with at once, and carried out as rapidly as possible so as to free the train. If the move is by lorry the construction of a ramp for the loading of the Thresh will probably be necessary.

Special precautions against fire, especially when the accommodation is tented, are necessary; constant watchfulness must be observed and frequent inspections of the arrangements made. A common cause of fire is the throwing of cigarette ends between the tent walls and the protective sand bagging; and therefore every tent must be provided with prominent precautionary notices, and ash trays and bowls which will hold water. Stoves for warming purposes should be constructed of masonry, the flues being well outside the tent walls, and chimney joints made tight, and cowls provided; if the flue pipe passes out near roofing or sides, the tent must be kept clear of it; there is great danger from sparks from the chimneys so they must be swept very frequently to see that soot does not accumulate in them. This is especially important when wood is the fuel used. The flooring in the tent under and round the stove should be of iron or stone. Only those fires which are essential should be kept going through the night. A special orderly should be told off for "lamp room," away from the tents, lamps and oil. Inside the tents every lamp must have its place. They are best suspended from a central overhead wire, and must be provided with protective cowls to the chimneys; and hurricane lamps alone should be permitted to be moved as hand lamps. When lamps are first lighted they must be turned low till they are thoroughly warmed. The turning of wicks high in wards with bed patients who cannot attend to them is one of the most frequent causes of firing of lamps. Primus stoves in tents must be looked on as dangerous, and all manipulations such as replenishing of oil and lighting must be carried on outside and away from tent walls; stores require constant intelligent attention and cleanliness to keep them in order. In each tent there will be a copy of orders for fire, and the necessary fire buckets of dry earth and water will be placed at the entrance. These must be protected from rain and frost respectively. An "alarm post," centrally situated, or outside the night picket's duty tent, must be arranged for and fitted with an alarm "gong" of steel rail with striker, also pumps, water, and sand buckets and barrels, sandbags of dry earth, shovels, picks, axes and knives for

cutting tent ropes must be provided to allow speedy striking of a burning tent. Needless to say each tent or series of interlaced tents must be provided with lateral emergency exits.

Anti-aircraft protective measures must receive considerable attention when enemy bombing planes are active. Mention has already been made of the siting of the C.C.S. away from dumps of stores, supply depots, railway stations, the centre of towns, etc., and of the advisability of the construction of a separate railway siding. The intervals between tents should be much increased and the ground between dug or ploughed up. The tents themselves should be camouflaged and sand-bagged, and stretcher beds lowered to the ground at night. Large Red Cross strips, thirty inches by five inches, on a whitewashed background should be spread out on the ground as the sign to aircraft during the day of protection under the Geneva flag. At night, rules for the shading of lights and curtaining of windows, ventilators and doorways must be strictly observed. In single fly-tents lights show through the canvas unless properly shaded. Particular care must be taken to show no lights during loading and unloading of cars, and ambulance trains. With regard to the latter the loading is best done at dusk before lights are necessary, but carriage doorways and windows should all be curtained. At night the engine shows up and it should therefore be kept away from the train until the coaches are ready to start. Dug-outs for patients and sisters may be necessary if nightly raids take place. A proper alarm post and signal should be instituted to give warning of the approach of enemy planes. A night trip in one of our own planes, or a night air photo of the C.C.S. will give a good idea of the strict observance or otherwise of anti-light precautions.

Arrangements must be made for other necessary hospital functions, viz., dental, ophthalmic and laboratory work. A mobile pathological laboratory is usually provided for each group of C.C.S.'s and often a hygiene laboratory also is in the vicinity and available for work of chemical nature. Application for the Corps Foden lorry will provide additional help for disinfection.

In the office, schemes must be made out and kept ready, in the case of receipt of orders for (1) an advance, (2) a retirement, (3) active operations, and (4) transfer to another area. In these the immediate disposal of contained casualties is perhaps the first essential proceeding. For active operations applications for additional surgical teams and loading, unloading and carrying parties, and the submission of indents for additional stores and supplies of all descriptions must be made early. Amongst such would be included large numbers of stretchers, blankets, hot-water bottles, trestles, palliasses, dressings, splints, drugs and sera, Red Cross stores, rations, water, coal, and clothing, together with tents for their accommodation, and that of the extra staff. Duty time-tables to allow of reliefs of staff, both day and night, will be made out and adhered to as far as possible. The D.M.S. or D.D.M.S. usually holds a preparatory conference of C.C.S. and M.A.C.

Commanders, and at that arrangements can be made for the mutual interworking of units, and such details as the times and methods of "taking in," the nature of the casualties to be dealt with by individual units and the areas from which they will be drawn can then be settled.

The Staff Section.

This has its different areas for officers, sisters, and other ranks. Special attention must be paid to details in connexion with the sisters in order to preserve their health, which is likely to be affected by the heavy work and mental strain. Their quarters should be well away from the bustle of the C.C.S., and be quiet, with ample bathing facilities, sand-bagged and provided with dug-outs, and with beds below the level of the ground at night when bombing is likely. Comfortable day rooms are necessary; sisters should be encouraged to get away from the camp for a short period each day, use being made of Red Cross cars for this purpose when available. In the arrangement of their duties, when possible they should not be employed on night duty in ordinary circumstances; they should be changed frequently, especially in Gangrene and Resuscitation wards. Needless to say they should all be inoculated with T.A.B. Each sister should be provided with a book for taking down addresses of the very serious casualties for purposes of communicating with their relatives, and for recording messages of the dying.

All arrangements possible for the comfort of the other ranks should be made, and night duty men kept together. Particular attention is necessary to prevent lice infection. A bath book must be kept, frequent inspections, and bathing parades held and changes of clothing arranged for. Where liable to exposure to infection of V.D., continuous warnings should be given to the men. When possible entertainments and sports should be arranged to keep the men occupied with healthy recreation.

A CRITICAL REVIEW OF THE PRESENT POSITION OF BACTERIAL AGGLUTINATION.

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(*Continued from p.* 285).

V. Diphasic Variation.

The fact that certain micro-organisms can exhibit, either in the smooth or rough state, specific and group phases has been recorded by Andrewes [7] and by Krumweide [8]. Thus some strains of *paratyphoid* beta bacilli and of the *aertrycke-suipestifer* group may occur in such forms that they agglutinate specifically, i.e., such strains of *para* beta bacilli react only with anti-*paratyphoid* beta serum, and *aertrycke* bacilli only with anti-*aertrycke* serum; whereas other strains may agglutinate equally well with either serum. The former are regarded as consisting solely, or almost solely, of "specific components," and the latter as consisting of "group components" in greater or less degree.

Employing the absorption test, Andrewes found that the "specific phase possesses more than one hundred times the absorbing power for the specific agglutinins shown by the group phase, while the group phase is more than four hundred times as efficient as the specific phase for the absorption of group agglutinins."

The figures given by Andrewes for the absorbing doses required in such a crossed experiment are:—

	Gross critical absorbing doses	Corrected for titre
Ultra specific serum absorbed with specific phase ..	12,500 million	625 million
,, ,, ,, ,, ,, group ,, ..	1·007 billion	67,125 ,,
Pure group ,, ,, ,, specific ,, ..	2·97 ,,	185,315 ,,
,, ,, ,, ,, ,, group ,, ..	11,466 million	458 ,,

There is no question as to the facts, as anyone who cares to repeat Andrewes' experiments can readily prove for himself, provided that he employ the metriculous care of that observer.

The observations of Andrewes are most accurate, and he is careful to observe: "Throughout this paper it is assumed, as a working hypothesis, that the bacillary substance which evokes the formation of agglutinins *in vivo* is identical with that which combines with the agglutinins *in vitro*."

It is unfortunate that the following additional proviso was not also attached: "That it is also assumed as a working hypothesis that the agglutinogenic quality of the bacillary substances *in vivo* bears a quanti-

tative relation to its absorptive capacity *in vitro.*" Thus, one of the conclusions arrived at by Andrewes from the figures quoted above is: "It may be inferred that the group phase contains only about one hundredth the amount of specific agglutinogens present in the specific phase." This inference is not necessarily valid, and involves the assumption contained in the additional proviso.

But this second assumption is itself invalid, for, in the present communication, more than one example has already been adduced to show that the agglutinogenic quality of an antigen does not bear any relationship either to its agglutinability or to its absorptive capacity. The influence of heat on flagellar agglutinogens is the most striking example of this.

It is difficult, then, to accept Andrewes' results as giving quantitative information concerning the "antigen-mosaic" of a specific, as contrasted with a group phase of the same micro-organism.

A much more important question therefore arises: Can we then accept them as indicating that the specific phase has *any* excess of a special specific antigen, and the group phase a similar excess of a separate group antigen? In other words, is not the division into specific and group phases more apparent than real?

The suggestion contained in the above question is: That *all* the antigenic constituents *as an indivisible whole* may be represented in the two phases and may—quantitatively at least—be *equally* represented in both. As an alternative hypothesis, we might consider the micro-organism as consisting of a single complex antigen, possessing both specific and group qualities. It is possible that in the specific phase, taking an extreme example, we may have the following arrangement:—

	Agglutinability	Absorptive capacity	Agglutinogenic capacity
Specific quality	+	+	+
Group quality	−	±	+

That is:

(*a*) The specific phase would agglutinate, would absorb, and would stimulate the production of agglutinins for itself.

(*b*) The group quality being in an inagglutinable condition, the results of simple agglutination tests would be specific.

(*c*) The group quality being of low absorptive capacity, the specific phase would be inefficient for absorbing a group serum.

(*d*) The agglutinogenic capacity of the group quality being still present, sera prepared from specific strains would agglutinate both homologous and heterologous group strains.

A corresponding arrangement of the group strain, again an extreme example, would be:—

	Agglutinability	Absorptive capacity	Agglutinogenic capacity
Specific quality	−	±	+
Group quality	+	+	+

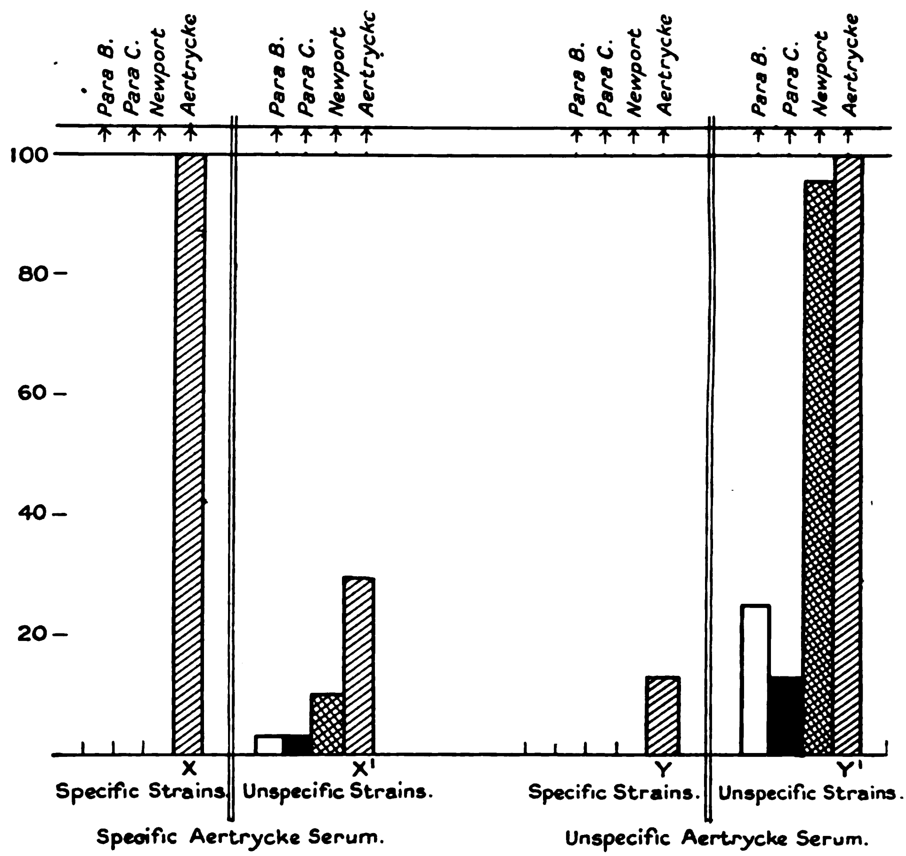
(*a*) The group phase would agglutinate, would absorb, and would stimulate the production of agglutinins for itself.

(*b*) The specific quality, being in an inagglutinable condition, the results of simple agglutination would be non-specific.

(*c*) The specific quality being of low absorptive capacity, the group phase would be inefficient for absorbing a specific serum.

(*d*) The agglutinogenic capacity of the specific quality being still

TABLE XVII.[1]



present, sera prepared from group strains would agglutinate homologous specific strains.

If this alternative hypothesis be not incompatible with observed facts, it is quite as acceptable as the view that the relative *quantities* of assumed divisible antigenic constituents vary from one strain to another.

[1] (Quoted from *Journ. of Path. and Bact.*, 1922, vol. xxv, p. 516.)

Table XVII quoted from Andrewes shows that, so far as simple agglutination is concerned, this alternative hypothesis is not incompatible with observed facts.

An examination of Table XVII—(cf. columns marked x and y, x′ and y′) suggests, however, that the agglutinogenic capacity of the specific quality in the group phase, and of the group quality in the specific phase, are much depressed. At first sight, therefore, it appears that the alternative hypothesis is less tenable than that advanced by Andrewes, for the figures suggest *quantitative* differences in the proportion of two hypothetical separate antigens. On the other hand, the unquestioned acceptance of this as evidence of quantitative difference ignores the possibility that two *qualities*, specific and group, present in the bacilli in different conditions, may stimulate reaction in the animal in different degrees.

Andrewes himself recognized that complications of this kind might arise, for, in a later publication [24], he says: "When we immunize a rabbit there is no certainty that the animal responds by producing antibodies in strictly quantitative proportion to the two or more antigens introduced."

Moreover, the discrepancy of x and y with x′ and y′ is not in every instance so marked as that figured in Table XVII, for in his second communication Andrewes quotes the following: "Agglutination titres of ultra-specific and pure group serums for specific and group bacilli.

(1) Ultra-specific *B. suipestifer* serum absorbed with specific *B. suipestifer*, unabsorbed control estimated titre, 20,000.
(2) Ultra-specific *B. suipestifer* serum absorbed with group *B. suipestifer*, unabsorbed control estimated titre, 15,250.
(3) Pure group *B. suipestifer* serum absorbed with specific *B. suipestifer*, unabsorbed control estimated titre, 16,340.
(4) Pure group *B. suipestifer* serum absorbed with group *B. suipestifer*, unabsorbed control estimated titre, 25,000."

In this instance, then, the ratios would be:—

x	100 per cent
x^1	76·25 per cent
y	65·36 ,,
y^1	100 ,,

Summary:—

It must be clearly understood that the practical value of those observations which permitted of the differentiation of certain Salmonella bacilli into group and specific phases is not questioned, and that the criticisms offered in this section of the present communication deal solely with the theoretical considerations that arise from such differentiation. There is no doubt as to the occurrence of two phases in certain of the Salmonella bacilli, and for purposes of description these may be referred to as specific and group phases.

It must be realized, however, that there is more than one explanation

of the facts observed, and it is by no means proved that the one phase differs from the other because of excessive development of a separate specific antigen in the specific phase or of a separate group antigen in the group phase.

It seems doubtful if it is justifiable to regard the occurrence of these two phases in cultures of the Salmonella bacilli as evidence of real variation of bacterial species.

It is important that this be noted lest it be assumed that diphasic variation constitutes an adequate foundation upon which to base theories concerning the phylogenesis of bacterial species or the relationship of one "species" to another.

VI. Relationship of Chemical to Serological Analysis.

The subject of variation of bacterial species and the antigenic constitution of micro-organisms has been studied from yet another standpoint, viz.: correlation of chemical analysis with serological reaction.

This method of inquiry has been much stimulated recently owing to the numerous papers of Avery and Heidleberger [23] dealing with the various types of pneumococci, also of Heidleberger, Goebel and Avery [24] dealing with the relationship of certain strains of Friedländer's bacillus to Type II pneumococci. Briefly, the findings of these investigators are that by appropriate chemical treatment pneumococci and Friedländer's bacillus can be broken up into (*a*) a protein constituent, (*b*) a carbohydrate constituent. The latter is apparently a polysaccharide.

The protein constituent is common to all types of pneumococci, while the carbohydrate constituent is type specific, i.e., reacts only in presence of antiserum to the homologous type.

Furthermore, there are distinct chemical differences between the polysaccharides obtained from each type of pneumococcus, while a remarkable similarity is noted between the carbohydrate constituent of certain strains of Friedländer's bacilli and that derived from Type II pneumococci.

From the *in vitro* standpoint the protein constituent reacts but feebly, whereas the carbohydrate constituent exhibits a marked delicacy of reaction, precipitating when mixed with homologous serum in dilutions as low as 1 in 2,000,000 and even 1 in 10,000,000. This carbohydrate constituent is not, however, antigenic, for it fails to call forth an immunity response when inoculated into animals, i.e., only so long as it is linked to the organism as a whole does it possess antigenic properties.

The carbohydrate moiety with which is associated the type specificity of pneumococci exhibits still another remarkable quality. It is a substance of very considerable stability, for the process used in its preparation is complex and involves exposure to a variety of chemical reagents and to a temperature of 100° C.; indeed, it loses its specific precipitating quality only when it is hydrolysed as, e.g., by exposure to strong acids.

A further series of observations by Reimann [25] are especially interesting in this connexion, for this author finds that degraded rough variants of the type pneumococci lose their type specificity and then exhibit the same characters as the separated protein constituent of the micro-organism, being "species specific" but not "type specific" both *in vitro* and *in vivo*.

In discussing his findings, Reimann says, "It would seem therefore that R (rough) pneumococci stimulate the formation of antibodies by virtue of the protein constituent of the cell-body. Previous mention has been made of the absence of capsule formation and of the associated specific (carbohydrate) substance in the R (rough) strains. Consequently, the R (rough) strains, devoid of the type specific antigen, cannot stimulate the formation of antibodies reactive with the type specific substances, and therefore have only the antigenic properties of the isolated protein."

There is no question as to the findings of Reimann, but the evidence upon which the statement is based that the rough forms are devoid of carbohydrate is:—

(1) That in these, type specificity, as determined by *in vitro* reactions, is lost.

(2) That on inoculation into animals such R forms fail to give type specific sera.

This evidence, although strong, is only indirect, for the use of the direct method for determining the absence of the carbohydrate constituent—failure to demonstrate it by chemical methods in cultures of rough pneumococci—has not at the time of writing been reported.

This is not intended as a criticism of Reimann's work, and is merely given as a warning, as we have so frequently encountered instances in which true antigens, undemonstrable by *in vitro* methods, are revealed by *in vivo* tests on the one hand, while on the other the heterogenetic reactions exemplify instances in which "antigens" are demonstrable by *in vitro* but not by *in vivo* methods. It therefore behoves us to be very careful in drawing conclusions, based upon serological tests, concerning the antigenic constituents of micro-organisms, for it is possible that the carbohydrate constituent is present in the rough forms of pneumococci, but is present in such form, or has such linkage with the protein constituents, that it is not demonstrable by the serological methods employed. For this reason correlation of chemical with serological analysis would have to be *complete* before one accepted these findings as proving that the carbohydrate constituent was absent from the rough forms.

It is emphasized that the present writer deeply appreciates the excellence of the work of the authors quoted and only offers the above observation lest proof of strict correlation between so-called serological analysis and chemical analysis be accepted on insufficient evidence, for acceptance of the correlation would lend to "receptor analysis" an appearance of exactitude which it does not possess. Such acceptance would also be liable to lead to false generalizations concerning the antigenic structure of bacteria and their relationships to one another.

That features demonstrable by chemical analysis are not without significance in immunology is indicated by the findings of Avery and Heidleberger, *et al.* [26], who showed clearly that immunization of animals with certain strains of Friedländer's bacillus protects these animals against infection with Type II pneumococci, the only quality common to the two micro-organisms being apparently that the same carbohydrate constituent is obtainable from both.

Observations that have been made concerning the chemical constituents of pneumococci, virulent (smooth) and avirulent (rough), of streptococci and of Friedländer bacilli are, considered alone, extremely suggestive, but difficulty arises when we attempt to correlate them with observations made upon other micro-organisms.

On comparing, e.g., the conclusions of various authors previously quoted concerning the specific antigen of the Salmonella bacilli and those concerning the specific factor of the pneumococci, as demonstrated by chemical analysis, it is found :—

(1) That in the case of Salmonella bacilli, *B. typhosus*, and similar micro-organisms, the specific antigen is apparently labile, and though, so far as I am aware, no attempt has so far been made to obtain it by chemical procedures akin to those used for the preparation of the pure specific precipitable substance of the pneumococcus, it seems highly improbable that it could be isolated by such methods on account of its lability. The specific precipitable substance of the pneumococcus is characterized by its extreme stability. Specificity of reaction is said to be dependent upon these factors : A labile factor in the "colon-typhoid enteritidis" group, and a stable factor in the pneumococci, so that no general rule can be formulated concerning the specific quality in terms of lability or stability.

(2) Moreover, as shown by Zinsser and Parker [27], residue antigens resembling the carbohydrate fraction of pneumococci in stability, in method of extraction, and in failure to call forth response on inoculation into animals, can be obtained from a great variety of micro-organisms, including *B. typhosus*. Two possibilities therefore arise :—

(*a*) The residue antigen of *B. typhosus*, corresponding to the carbohydrate fraction of the pneumococci, may be the specific antigenic factor of that micro-organism. If this be so, it should be possible to determine a relationship between such residue antigen and the labile constituents of *B. typhosus*, if, as appears to be the case, the specific antigen of that micro-organism is labile.

(*b*) There may be two specific factors in *B. typhosus*, one connected with the labile fraction, and the other with the residual antigen.

On considering these possibilities from the view-point of antigen analysis, the second one—(*b*)—appears the more probable, for the preparation of the residue antigen involves boiling in weak acid. It is possible, on the other hand, that the residue material is able to withstand heat when

its linkage with the accompanying protein is broken. If this were so, the first possibility (*a*) would not be invalid. It is obvious that technical difficulties of a serious nature will be encountered in any attempt which is made to determine which of these hypotheses (*a*) or (*b*) is correct.

A second aspect of this question of residual antigen must be noted, viz., that Reimann [25] suggests that the rough pneumococci may be regarded as smooth pneumococci deprived of their carbohydrate constituent, so correlating chemical with serological analysis, and both methods indicating that the precipitable substance (? residue antigen) is the specific factor. On the other hand, among the Salmonella bacilli, roughness and lack of specificity have no relationship to one another, and a rough Salmonella strain may be specific or non-specific.

In place, then, of roughness being associated with deprivation of an antigen in the Salmonella bacilli, it is, according to the pictorial representation of the observed facts, to be associated with a change in the heat-stable antigen.

Thus, the pictorial interpretation of the serological findings in the case of the pneumococcus, when it becomes rough, is:—

A + B (smooth and type specific) by deprivation of A becomes B (rough and only species specific).

In the Salmonella bacilli, however, we appear to have A + B (smooth and specific) by alteration of B becomes A + B′ (rough but specific).

A in the pneumococci is a very stable carbohydrate constituent, resident perhaps in the capsules.

A in the Salmonella bacilli is, so far as is known, a labile constituent, and, according to some observers, is present mainly in the flagella.

If it could be shown that rough Salmonella bacilli do not possess residual antigen in the sense of Zinsser and Parker [27], while smooth Salmonella bacilli do, then it could be stated as a generalization that roughening is dependent upon deprivation. The investigation of that possibility is at present proceeding in this laboratory.

If such investigation shows that residual antigen is present in the rough Salmonella bacilli, it would indicate that no general explanation of the process of roughening can be given, and that the correlation of chemical with serological analysis is incomplete, so that in the case of the pneumococci such correlation may be only accidental.

The correlation of chemical with serological methods of antigen analysis can, however, be viewed synthetically instead of analytically, and this has been done by Landsteiner and Simms [28], Landsteiner and Lampl [29], Landsteiner [30], and by Landsteiner and van der Scheer [31].

The first of these papers deals with the process of lysis by heterogenetic antibodies, and the findings are very significant, in that they show clearly:—

(1) That the alcohol-soluble fraction of a heterogenetic antigen, which fraction reacts markedly *in vitro*, is not an efficient antigen on inoculation.
(2) If the alcohol-soluble fraction be injected into animals when mixed with a protein of quite foreign origin (i.e., different from the protein from which it was extracted), the mixture is relatively efficient in stimulating production of lytic antibody on inoculation.
(3) When the protein and alcohol-soluble fraction are injected separately the production of such antibody is not stimulated.

This can only mean that the quality of an antigen is profoundly influenced by its physical state, for one can scarcely conceive of a mixture of saline suspension of alcoholic fraction forming at room temperature even a loose, but true, chemical union with added protein. For this reason the correlation of chemical analysis with immunological reactions presents great difficulty.

The later publications of Landsteiner and his associates, with the exception of that quoted last [31], deal with the serological reactions and antigenic qualities of azoproteins. The results show that the serum of animals immunized against one azoprotein precipitates specifically azoproteins whose protein constituent is different from that used for immunization *provided that the azo-component is the same.* Moreover, animals sensitized with an azoprotein exhibited anaphylaxis to other azoproteins provided that the azo-component is the same in both. The simple compounds used to make the azoproteins did not cause shock in the animal sensitized to azoprotein, but did appear to be efficient for producing the anti-anaphylactic state in such animals. In these experiments, then, the correlation between chemical character and specificity of immunological reactions, both *in vitro* and *in vivo*, appears to be complete, and one must conclude that some relationship does indubitably exist between chemical structure and immunological reaction. It is to be noted, however, that the experiments are highly artificial, and, although they are suggestive, one cannot justifiably conclude that group agglutination reactions depend upon the organisms, or cells, which show group relationship, containing a common antigen, as is so frequently suggested in the pictorial representation of immunological experiments.

Indeed, Landsteiner himself is particularly careful to avoid any assertion that such is the only interpretation of his findings, notwithstanding the fact that these findings furnish the strongest argument for the view that a close correlation exists between the chemical constitution of an antigen and its immunological reactions.

This caution in interpretation is clearly indicated by Landsteiner and van der Scheer [31], who conclude, from observations on the reactions of an antiserum to pure horse-euglobulin with homologous and heterologous antigens, and also of similar observations on precipitation of azotized

proteins, that "The results of partial saturation of precipitins with antigens related in derivation to the homologous one give no conclusive evidence of the regular existence in a single immune serum of multiple antibodies which act specifically on various chemical groups of the antigenic protein. It seems possible to explain at least part of the facts by the assumption that a single antibody will react to different degrees with several similar substances."

On the other hand, it must be noted that in the case of hæmagglutinins he states that: "By the partial absorption of hæmagglutinins with heterogenetic blood specific fractions were obtained." A later paper of Landsteiner and van der Scheer [31] throws light on the apparent discrepancy between the results of precipitin and hæmagglutinin reactions, for it is found that: "Erythrocytes contain more than one substance responsible for the production of lysins and agglutinins. By injections of alcoholic extracts of horse erythrocytes, mixed with a foreign serum (pig serum), hæmolysins and agglutinins can be more rapidly obtained than by the same quantities of (alcoholic) extracts alone. The immune serum (so obtained) reacted on horse and donkey blood, but not on the blood of other species."

Such antibodies exhibit characters which recall those of heterogenetic antibodies and differ therefrom only in being relatively specific for animals of closely allied species.

It is to be noted, however, that the stromata of red cells deprived of their lipoids act as an efficient antigen, as is shown by Thiele and Embleton [32], Balls and Korn [33], Bennett and Schmidt [34], while Schmidt and Dement [35] find that a globulin separated from red cells acts in a similar manner.

In hæmagglutination and hæmolysis, therefore, there appear to be two separate factors: (*a*) That related to the stromata of the cells; (*b*) that connected with the lipoids of the cells, the latter having characters so resembling the heterogenetic "haptenes" that one is left in doubt as to their precise significance as "antigens" in the restricted sense of that term.

If, bearing these facts in mind, the problems of agglutination of bacteria be reviewed, it is seen that we may possibly have group reaction dependent upon more than one relationship. A micro-organism is like a red cell, in that it is a formed element and contains, according to species, a variable quantity of lipoids; it also contains proteins, and therefore group reactions may depend on:—

(1) A mechanism similar to that determined by Landsteiner in the analogous relationship of precipitins, viz., *one* antibody able to act on several antigens.

(2) A mechanism similar to that observed by the same author in hæmagglutination and hæmolysis.

In view of this it is difficult to accept the method of receptor analysis as being suitable for investigating the so-called "antigen-mosaic" of bacteria, for the method is valid only if one assumes that a multiplicity of

separate antibodies is present in antibacterial sera. There is no need to make such an assumption, for mechanism (1) could explain the facts, and mechanism (2) could co-exist—and probably does co-exist—with mechanism (1).

Summary.

The correlation of receptor analysis, by serological methods, with chemical analysis, designed to investigate the antigenic structure of micro-organisms, is not complete.

There are indications that serological methods may show apparent group relationships between different antigens because of two factors:—

(1) That one antibody may react with several different antigens.

(2) That reactions resembling those which occur between heterogenetic antibody and antigen may be observed when an antigen consisting of formed elements, and, therefore, in most instances containing a variety of substances, is used for immunization.

(*To be continued*).

Editorial.

REPORT ON THE HEALTH OF THE ARMY FOR THE YEAR 1925.

THE annual reports on the health of the Army are following one another with almost disconcerting rapidity. Those for 1923 and 1924 were noticed in the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS in January and August of last year and now the report for 1925 has reached us with the shock of pleasant surprise. Within little more than a year we have thus had three annual reports to review, with the result that information regarding the health of the Army can now be ascertained within a comparatively short time of the period to which it refers. It is rarely, if ever, that the Army and the public generally has had this good fortune, and we may say at once that the changed conditions are not attributable to any curtailment of the statistical records and explanatory text, nor, presumably, to any acceleration in the formalities of printing and publishing; but rather to the combined efforts and organization of the administrative medical authorities at the War Office and in the several commands at home and abroad. It is a pleasant duty to offer them our congratulations on their achievement and to express a hope that they may live up to it.

As in 1923 and 1924, the report for 1925 consists of three main sections: A general survey of the health of the Army with notes on the salient features of the principal diseases causing inefficiency; a summary of the work of the special departments of medicine, surgery, hygiene, pathology, dentistry and recruiting; and detailed statistics and notes of the health of the troops in each individual command at home and abroad.

The health of the Army throughout the year was good. Reductions were effected in the admission, death, invaliding and constantly sick-rates amongst "other ranks," although not to the same extent amongst officers. The average strength of the latter was 9,909 with an admission rate of 296·3 per 1,000 and a death-rate of 4·44, as compared with 284·4 and 5·86 in 1924, and 286·9 and 3·93 in 1923. The constantly sick-rate, 13·46, was also higher than in the two previous years, when it was 12·99 and 13·03. The average strength of other ranks was 193,597. The ratio of admissions was 446·2 per 1,100, as compared with 484·7 in 1924 and 484·0 in 1923; but the ratio has not yet fallen to that of 437·7 in 1913. The death-rate, 2·35, compares favourably with 2·80 in 1924 and 2·84 in 1923, as also do the invaliding and constantly sick rates, which were 11·12 and 25·70 respectively, against 13·00 and 27·11 in 1924 and 14·50 and 28·54 in 1923. These are of course slight reductions, but they mark a steady downward movement of the ratios.

The principal causes of admission to hospital are practically the same as in 1924; malaria with 10,019 admissions heading the list, followed by venereal diseases with 8,591 admissions (of which 6,424 were for gonorrhœa and 894 for syphilis), inflammation of tonsils with 6,008, of the areolar tissue with 4,582, and of the bronchi with 3,286. Influenza, sprain and sand-fly fever come next in order with 3,047, 2,592 and 2,397 admissions respectively. None of the diseases show any significant increase over the previous year; while malaria and influenza have greatly decreased, the former from 71·0 to 51·8 per 1,000 and the latter from 34·6 to 15·7.

The death-rates call for no special remarks. The highest rates were for injuries (0·39 per 1,000) and pneumonia (0·33 per 1,000). With regard to invaliding, there is again a marked preponderance of cases of inflammation of the middle ear. The number of invalids discharged the service on this account was 449 in 1925; the next highest numbers being 256 for tubercular diseases and 139 for valvular disease of the heart. In 1924 the number discharged for middle ear disease was 409, and this significant increase is being specially investigated. Pulmonary tuberculosis as a cause of invaliding has also increased; but against this there has been a marked decrease in disordered action of the heart, for which only 81 were discharged in 1925 as compared with 147 in 1924.

The notes on individual diseases and groups of diseases will be found of special interest to the readers of this report. We can only indicate a few of the more salient points. In the first instance predominating importance is given to those diseases of the digestive system which could not be assigned to any specific causal agency. In 1925 they were the cause of 9,266 admissions to hospital, or 47·9 per 1,000 of the strength, with 434·44 constantly sick. These figures are considerably higher than in the two previous years, and were the subject of special investigation. The group included such disorders of digestion as gastritis, dyspepsia, gastric and duodenal ulcer and appendicitis. A systematic examination was carried out in all cases in which the symptoms suggested a definite lesion. Pain and tenderness were correlated with the results of a fractional test meal, presence of occult blood, and fluoroscopy and radiography of the stomach and intestines after a barium meal. When ulcer was definitely diagnosed, medicinal and dietetic treatment was tried before resorting to an operation, and many cases showed good results on Hurst or Lenhartz diets; but preliminary removal of dental or other foci of infection was essential. The cases of gastric and duodenal ulcer treated surgically gave excellent results. Sixteen of the former, nine being emergency cases on account of perforation, were operated on, and all recovered. Of fifty-three duodenal ulcer cases, twenty-five were treated surgically, with two deaths, one from hæmorrhage and the other from toxæmia after a subphrenic abscess had developed. No fewer than fifteen of these were urgent operations on account of perforation. All who recovered after operation returned to duty and barrack-room diet; and none had to be invalided. While most of the

operations were done by a few surgical specialists, many operators contributed one case each; and, to quote the report, "the work reflects the average that can be expected from a body of general surgeons rather than the statistics produced by a single expert devoting much of his time to gastric surgery."

In connexion with dysentery, the question of accuracy in diagnosis, bacteriological and protozoölogical, occupies a prominent place. Of the total admissions, 588 or 67·9 per cent were diagnosed as amœbic, as compared with 87·3 per cent in 1924. In Poona most of the cases were returned as bacillary dysentery, but 498 of the 725 cases in India as a whole were amœbic, with only 85 bacillary and 142 group infections. Iraq has still the highest incidence, but the ratio fell from 38·6 to 19·0 per 1,000 in that command. Prophylactic inoculation for this disease, the report states, is not yet a practical proposition, and warfare against flies is the chief measure of protection.

With regard to enteric fever, India provided 184 of the 218 cases admitted during the year among the troops, giving practically the same admission ratio as in 1924. The inoculation state of the British troops there was 95·3 per cent, and of officers 87·2 per cent; but no information is given of the incidence of the disease amongst the non-inoculated in India. This is to be regretted.

We have already referred to the marked decrease in the incidence of malaria. West Africa, India and Iraq were the commands most affected, but the ratio of admissions in them fell from 421·1, 206·8, and 196·8 respectively to 357·1, 159·0, and 106·8 per 1,000 of strength. Another disease deserving notice is sand-fly fever, for which there were 410 admissions, or 405·5 per 1,000 of strength in Iraq in 1924. In 1925 this was reduced to 239·8 per 1,000; and similar reductions took place in Malta, India and Egypt, the commands which contribute these cases. In Egypt attention was drawn to the relationship between sand-fly fever and pyrexia of uncertain origin. Statistically, there was a marked decrease in both diseases, as compared with 1923 and 1924. The ratios for sand-fly fever in 1923, 1924 and 1925, in Egypt, were 47·8, 32·6, and 11·3 respectively, and for pyrexia of uncertain origin 32·4, 47·7, and 12·4 per 1,000.

A note on the value of "Von Heyden 471" in the treatment of cases of kala-azar is important. The evidence is accumulating to show that this drug is the most reliable and effective in the treatment of these comparatively rare cases in the Army.

No other disease or group of diseases calls for special mention here except venereal diseases. With regard to these there is much that is of interest and importance, for no other disease was responsible for so much inefficiency as gonorrhœa, if we estimate inefficiency by the average number constantly sick. For this disease there were 971·42 constantly sick out of a total average of 4,975·35 for all diseases; the nearest approach to this number being 275·23 for malaria. Presumably the gonorrhœa cases are

kept in hospital until they are bacteriologically pure, and this may account for the high number constantly sick. The question may be asked whether this bacteriological purity is not carried too far. During the war, both in the American and French armies, and later to some extent in ours, these cases were not relieved, at any rate in their chronic state, from military duties. One or two interesting statements regarding preventive measures against venereal diseases occur in the report. Investigations were made in three stations in order to arrive at some conclusion as to use of preventive outfits. Out of 968 cases so investigated, 59·9 per cent had taken no precautions, 388 had used the outfit, but of that number 181 had used it incorrectly. On the other hand, preventive ablution centres gave extremely good results in Malta and Quetta. In Malta venereal diseases ratio fell from 59·1 per 1,000 in 1923 and 41·4 in 1924 to 24·8 in 1925, and this drop is said to be due to the work of ablution centres in certain streets. In Quetta 6,057 men used a central prophylactic treatment room in the bazaar, and only 8 subsequently developed venereal disease.

With regard to the work done in the special departments, we are told that in the medical section X-ray treatment of thyroid enlargement was tried with considerable success; and that an intractable case of amœbic dysentery was cured by rectal injections of *yatren*. In the surgical department's report mention is made of progress and improvements in anæsthetics, radiology, massage and electro-therapeutics, and in the ophthalmological and ear, nose, and throat work. In these two last named departments, there is a lack of specialists. Only one officer qualified in ophthalmology, and two in ear, nose and throat diseases in 1925, and much of the work has still to be carried out by civilian practitioners.

The chief interest in the report of the hygiene department is in the account of the special investigations at the Royal Army Medical College. Two samples of lemon juice were tested for their antiscorbutic properties, one when received, the other after six months. The first was found to possess antiscorbutic properties, but short of the equivalent of fresh vegetables; the other had lost much of these properties; but we can scarcely regard these investigations as sufficient for drawing definite conclusions. Another line of investigation was on the effect of bisulphate of sodium solutions on an aluminium water-bottle lined with oxide of aluminium. As was foreseen many years ago the oxide scaled off and the acid solution dissolved the aluminium. Amongst the subjects considered by the Army Hgyiene Advisory Committee were a special pattern of boots for recruits, water sterilization by chloramine, an improved pattern of shirt, and the effect of work in tanks on the personnel of the Royal Tank Corps. A special recruit's boot, raising the inner side of the sole and heel one-third of an inch, had been issued to certain depots in the hope of diminishing the development of acute flat-foot during training, but the statistical results of the experiment were not available at the time of the report.

In the pathological account, there is an important note on the prophy-

lactic vaccination against colds. The experience gained in the use of "mixed cold" vaccine showed that, if inoculation is postponed till November, it is liable to be followed by a severe cold, because of a negative phase at a time when exposure to infection is inevitable. Prophylactic inoculation should therefore be commenced before the onset of winter. Another interesting investigation was into the blood condition and health of military workers with X-rays. No pathological changes in their blood-counts or deterioration in their health were observable; an indication that the measure of protection was satisfactory.

The dental department of the Army grows in importance as may be gathered from the notes and statistical tables in the report. Finally there are the statistics of the medical examination of recruits. The number examined in the recruiting year 1924-25 was 57,447, of whom 19,384 or 33·74 per cent were rejected on enlistment and 1,021 or 1·77 per cent within six months' service. These figures are better than those of the previous year, when the ratios of rejection and discharge within six months were 36·37 and 2·97 respectively. As in previous years the chief cause of rejection, 3·79 per cent., were diseases of the middle ear, an increase from 2·47 in the three previous years. On the other hand, failure to reach the standard of chest measurement has fallen from a ratio of 2·08 per cent. in 1923-24 to 1·41 in 1924-25.

In the reports of the health of the troops in individual commands there is nothing of special interest, except in the report from the Indian Command, special points in which have been referred to above. The report also includes statistics and a few notes on the health of gentlemen cadets, the Boys' Technical School, Beachley, and the women and children. It is a document to which the attention of every officer in the R.A.M.C. should be drawn; and it should be the duty of every officer to read and study it. In its present form the Annual Report on the Health of the Army is less dull reading than its predecessors before the war; at the same time continuity of statistics for comparative purposes is maintained. We would like to see a free issue to all officers, instead of their having to depend on obtaining the copy from an administrative office, from which we fear it, sometimes, never emerges.

Clinical and other Notes.

TWO CASES OF PERFORATION OF THE ILEUM.

By Captain R. H. C. PRYN.

Royal Army Medical Corps.

The following two cases present several points of interest, which will be indicated later.

Case 1.—Private W., aged 22. He was admitted to hospital on March 8, 1926, with a history of having been detained with his unit for one day with a temperature of 104° F., which was ushered in by a rigor. The blood-smear was negative to malaria. The date of his last inoculation for T.A.B. was March 1. On examination nothing definite was noted except a palpable and slightly tender spleen.

Treatment.—Milk diet. Mist. quin. sulph. ten grains t.d.s., which was discontinued after five days' trial, as it had no effect on his temperature.

Progress.—The patient's condition continued the same until March 15, when the perforation occurred. He did not appear very ill, his bowels were open regularly, and his motions appeared normal. His temperature, at first continuous and averaging about 102° F., became remittent on March 14. Blood was taken for culture and Widal on March 13. The blood gave pure growth of *Bacillus pyocyaneus,* and the Widal reaction was as follows: T—S in 2,500; A—S in 1,250; B—S in 2,500.

March 15: Perforation. At 10 a.m. the patient complained of some discomfort in the right iliac fossa, and there was some muscular resistance on that side with a little tenderness. His pulse was taken every half hour and charted, and he was carefully observed. I saw him again at 12 mid-day. His pulse had not risen, but just before he was examined he experienced a severe abdominal pain, his face became pinched and his abdomen very rigid and tender. At the same time he developed a very severe rigor and his temperature and pulse rapidly rose to 104·8° F. and 112 respectively. It was obvious that perforation had occurred, and he was placed in Fowler's position, rectal saline, half pint, and other restoratives being given.

Operation, 2 *p.m.*—The anæsthetic, which was administered by Major S. S. Dykes, R.A.M.C., was chloroform and ether, preceded by the usual injection of morphia and atropine.

A right paramedian subumbilical incision was employed. Serous fluid and bowel contents were present in the peritoneal cavity.

The lower four or five feet of the ileum were intensely congested, the appendix was normal, but there was what appeared to be a typical typhoid

ulcer on the antimesenteric aspect of the ileum about ten inches from the ileo-cæcal valve. The ulcer was situated in the long axis of the gut, and had a small perforation in its centre. It was invaginated by a row of Lembert sutures in the transverse axis of the gut, and the abdomen was closed after arranging for pelvic drainage.

After-treatment and Progress.—Patient was placed in the Fowler's position, continuous rectal saline with two per cent glucose was given, and later nutrient enemata of peptonized milk were added. Everything was withheld by the mouth for five days, and he was given a quarter of a grain of morphia twice daily for the two days following operation.

His condition improved markedly, and on the morning following the operation his temperature was 97° F., and pulse 68. He had no pain and his abdomen was supple, with little tenderness. His bowels acted normally on March 18, and culture of the stool demonstrated *B. pyocyaneus*. On March 20 (five days after operation) he was given citrated milk in small feeds at two-hourly intervals.

From the afternoon of the 20th he complained of feeling weaker, and though his temperature was normal and his abdomen supple and free from pain, his pulse showed a tendency to rise, until at 4 p.m. his temperature dropped from normal to 95° F., and his pulse rose to 132. Shortly after this he vomited milk tinged a peculiar light green (evidently containing *B. pyocyaneus*).

The patient died next day with a thready and uncountable pulse, but a normal temperature and supple abdomen with no pain or tenderness.

REPORT ON PARTIAL AUTOPSY BY CAPTAIN A. MEARNS, R.A.M.C.

Body is that of an emaciated man. Rigor mortis setting in; no cyanosis or post-mortem lividity.

Abdomen: The small intestine from two feet from the pylorus to the cæcum is markedly hyperæmic and inflamed. About ten inches from the cæcum there is an area of greater inflammation with a film of yellow lymph [1] and fibrin thereon and on contiguous coils of intestine. On removal of this film a small perforation is seen surrounded by tiny erosions of the peritoneal surface in the position of the stitches, which have been absorbed. There is no other sign of peritonitis. The intestine is not distended, but contains green fæcal matter.[1] The mucosa is generally inflamed throughout its length. Peyer's patches and solitary glands are not enlarged. The mesentery is hyperæmic, and the glands therein, especially those related to the perforation area, are inflamed.

Stomach and large intestine: empty and normal.

Spleen [1]: Three and three-quarter ounces, is hyperæmic and friable.

Liver: Marked fatty degeneration.

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[1] *B. pyocyaneus* was isolated later from the lymph, fæcal matter and spleen.

Kidneys: Hyperæmic.

Heart and pericardium: Normal. Lungs healthy—no evidence of tubercle.

Case 2.—Private C., aged 24, a bandsman with a disposition which bids fair to rival that of Mark Tapley. He was admitted to hospital on February 13, 1926, with a history of two days' fever suggestive of malaria. Blood-smear showed malignant tertian rings. After the usual quinine treatment, including an intravenous injection of five grains of quinine hydrochloride, his temperature fell to normal in five days. Next day (February 19) his temperature started to rise again, and three days after this blood-culture demonstrated *Bacillus typhosus*. The primary attack lasted thirty-two days, and the temperature ranged round 104° F. At the end of this period the patient was very emaciated, but he had no lethargy and was cheerfulness personified. To the question, "How are you?" he would invariably reply with a cheery "All right, sir."

On April 5 he started a relapse, which lasted fourteen days, his temperature ranging round 103° F. On April 29 he started his final relapse, which lasted fifteen days, his temperature ranging round 102° F. It was this relapse which terminated in perforation. Throughout all this period he remained cheerful and there was no trace of any lethargy.

On May 12 the patient had had in all sixty-five days' fever. He was weak and extremely emaciated. For the past two days he had complained of some abdominal pain, and there was some tenderness and resistance in the right iliac fossa. At 9 a.m. he passed a solid brown stool, and it was noted that there were sloughs on it.

Perforation.—At 11.15 a.m. he became very cold, collapsed, and evidently had severe abdominal pain. There was board-like rigidity and great tenderness. His temperature was 97° F., and pulse 132. Though it was evident that an ulcer had perforated, it was at this moment, lying in bed, a living skeleton, with a hippocratic face, and in extreme agony, that he reached the acme of Mark Tapleyism. Bracing up his diaphragm and recti with a supreme effort, he said stoutly, "All right, sir." He was placed in Fowler's position, hot bottles were applied and eight ounces of rectal saline were given.

Operation, 12.45 *p.m.*—After preliminary intravenous saline, one pint, with one cubic centimetre of pituitrin and the usual injection of morphia and atropine, chloroform and ether were administered by Captain Sen, I.M.S. A right paramedian subumbilical incision was employed. There was much serous fluid and bowel contents in the peritoneal cavity. The perforation was found at the lower end of the ileum and was sutured with two transverse layers of Lembert sutures. The gut was very friable and injected, and the scars of several healed ulcers were noted. The abdomen was closed after arranging for pelvic drainage.

The patient showed a slight tendency to collapse for two or three days after operation, but made a wonderful recovery, and to-day, August 12, has completely regained his normal weight and health.

After-treatment was as follows: Fowler's position. Intravenous saline half a pint, and $\frac{1}{100}$th grain of digitalin were given soon after the operation, and continuous rectal saline was started at 5.15 p.m. One-sixth grain of morphia was given at midnight, and repeated at midday next day (May 14), and again at midday the following day (15). Two per cent. glucose saline was given continuously *per rectum* from May 14, and nutrient enemata of peptonized milk were added later. Nothing was given *per oram* until May 17, when sherry whey was given in portions of one ounce hourly, alternated with Brand's essence on the 18th, and the diet being gradually worked up from these small beginnings.

POINTS OF INTEREST.

(1) *The Pathogenicity of B. pyocyaneus.*—It is interesting to note that the causative organism in Case 1 was apparently *B. pyocyaneus*, which was isolated from the blood on the seventh day of disease. The same organism was isolated from the blood of another patient, who ran the typical course of typhoid fever; though his diarrhœa was very severe, and his stool assumed the grass-green colour which one associates with the enteritis of infancy; he made a good recovery, but it was necessary to diet him on whey only for nearly a week. A few cases of enteritis and intestinal ulceration due to this organism have been described, but it is probable that this form of infection is more common than is supposed.

(2) *The Warning Signs of Perforation.*—It is noteworthy that in both of these cases the perforation was preceded by some abdominal discomfort or pain, and that there was increased muscular resistance and slight tenderness. In each case, too, the temperature for a day or two prior to the perforation was intermittent. This was noticeable in other cases which developed slight tenderness and rigidity, but did not perforate. I think it is very probable that an intermittent or remittent temperature is an indication that an ulcer is approaching the peritoneal surface, and that there is increased absorption of toxins from the peritoneum causing a swinging temperature. It would be interesting to have other medical officers' experiences regarding this point.

(3) *The Diversity of the Symptoms of Perforation.*—Whereas in Case 2 perforation was accompanied by the usual subnormal temperature and rapid thready pulse of abdominal perforation, Case 1 had a marked rigor and a rise of temperature to 104·8° F., with a pulse of only 112. Pulse and temperature in cases of perforation seem to be very variable. In one case of gastric ulcer perforation, which I saw recently, the pulse two hours after perforation was only 40 to 50. The only constant signs of perforation would appear to be marked tenderness and hyperæsthesia, abdominal facies, and board-like rigidity of the abdominal wall.

(4) *Post-operative Peritonitis.*—Case 1 exhibits the seldom-seen symptoms and signs of post-operative peritonitis due in this case, not to

any error in technique but to the absorption of the sutures by the intensely inflamed and friable gut. In place of the usual symptoms of peritonitis we have the normal temperature, absence of pain, lack of rigidity and tenderness of the abdominal wall, but the rising pulse and increasing weakness of post-operative peritonitis.

(5) *The Use of Morphia in the After-treatment of Perforative Peritonitis.*—My experience with use of morphia in the after-treatment of perforative peritonitis is most happy, though its use is generally deprecated in textbooks. It appears to rest the gut, localize infection, and increase the absorption of fluids *per rectum*, which is so essential to toxin elimination. In no case have I seen any resultant distension which could not be controlled by a turpentine enema. My experience of this condition, it is true, is very limited, but I have been informed by surgeons of experience that morphia is a most valuable drug in the after-treatment of perforative peritonitis.

My thanks are due to Lieutenant-Colonel J. G. Foster, O.B.E., R.A.M.C., for permission to publish these notes; to Major G. Shanks, I.M.S., for helpful suggestions; and to Captain A. Mearns, R.A.M.C., for the report on the partial autopsy on Case 1.

FILLING FOR THE JOINTS OF TABLES.

By Major S. M. HATTERSLEY.

Royal Army Medical Corps.

Some months ago it was suggested that I should try to find some satisfactory method of dealing with the joints of the tables in the dining-room at the Army School of Hygiene.

It is well known that the joints of the ordinary trestle table became filled with dirt, and that however well the table is scrubbed the dirt lodged in them is not removed.

In considering the question it must be remembered that there is always the unknown factor of how much the wood may shrink or swell; however small this may be it will obviously affect a perfectly hard resistant filling. In addition, the tables are subject to rough usage, being frequently scrubbed with a hard brush, soap and hot water.

It was therefore thought that a filling of such materials as beeswax and resin might prove to be of use. Claud Worth in his book, "Yacht Cruising," gives a recipe composed of resin, beeswax and linseed oil for filling spars, but this composition was found to be too soft. However, by varying the quantities, a mixture of resin 12 parts, beeswax 4 parts, and linseed oil 1½ parts, produced a filling which was satisfactory, except that it was dark brown in colour. To overcome this, light amber resin and white beeswax were used, and though the colour of the resulting mixture was much

lighter, it was not until a little chalk was added that a filling was produced which matched the colour of the tables.

The method of making and using the filling is as follows: Heat 3 parts of linseed oil and stir in 24 parts of light amber resin, 8 parts of white beeswax, and 2 parts of chalk. It is best to powder the resin and cut up the beeswax before stirring it in. This mixture is then poured while hot into the joints of the tables until it overflows; as it is setting, a painter's scraper is run along the surface of the table and the surplus filling removed. This can be heated and used again, and any which cannot be removed by the scraper can be rubbed off with a little methylated spirits.

Hot water used in scrubbing the tables may momentarily soften the filling but this may be an advantage when the possibility of the wood shrinking or swelling is remembered.

The joints of the tables in the dining-room at the Army School of Hygiene have been treated in this way, some six months and others three months ago. The filling is still in good condition.

I do not think it would be of use in a hot climate as it has a low melting point.

A patent filling was also tried, but besides being expensive it was found to be difficult to work into the joints.

THE RECEPTION OF WIRELESS BROADCAST.

By Lieutenant.-Colonel F. A. H. CLARKE.

Royal Army Medical Corps.

Although wireless communication has been in use for some years, it is only of late that public interest has been stimulated by the adaptation of wireless telephony to the purposes of entertainment and instruction. The rapid development of the British Broadcasting Company, the improvement in scope and quality of programmes, and the arising of a very efficient wireless press, point to the fact that this interest is not ephemeral, but, on the contrary, gaining a stronger hold every day.

The reason is not far to seek. Not only is it, as an amusement, phenomenally cheap, but as a hobby it is unequalled by reason of the diversity of interest which can be aroused by the search for and trial of improved methods of reception.

It is thought that possibly some readers of the Journal, to whom the subject is at present a closed book, might be interested in a few notes on the methods by which these broadcast programmes are received.

A licence, cost 10s., can be had for the asking at any post office. The other essentials are: (*a*) An aerial; (*b*) an earth; (*c*) a receiver; (*d*) telephones or a loud speaker.

AERIAL.

The most efficient form is the outdoor aerial. There are various ways in which this may be constructed, but for our purpose a bare or enamelled stranded copper wire (7/22, i.e., composed of seven strands of twenty-two gauge wire) may be taken and suspended in such a way as to be free from contact with "earth"—trees, buildings, etc.—from its extremity to its termination at the aerial terminal of the set.

This insulation is obtained by means of porcelain insulators, preferably shell type, or of a special type of insulator, such as the featherweight insulators of the Silvertown Company, and by the use of either leading-in tubes or heavily insulated wire where the wire enters the house. The length of aerial is limited by the Postmaster-General to 100 feet, including the lead-in, and this is ample for the broadcasting wave length. A single wire is easily put up, offers little resistance to wind, and gives excellent results. Twin wires can be used, but these should be spaced six feet apart by spreaders of bamboo or other light strong wood, the same rigid precautions as to insulation being observed.

The shape of the aerial may be either inverted L or T. When the latter is used, it is important that the down lead should be taken from the exact centre of the horizontal portion. Bare wire should be used on account of the difficulty of making proper electrical connexion to the several strands of enamelled wire.

In erecting the aerial the following points are to be borne in mind :—

(*a*) The horizontal portion should be as high as possible. Every inch counts, and the greatest available height should be obtained.

(*b*) It should be "unscreened," i.e., clear of obstructions such as very adjacent buildings or trees.

(*c*) Insulation should be carefully attended to, at least, two insulators at the points where attachment has to be made to supporting wires or ropes.

(*d*) If rope be used as support, remember that wet causes considerable shrinkage, and make due provision for adjustment.

(*e*) The "free" end—i.e., end remote from receiving set—of the aerial should, if possible, point *away* from the station which it is desired to receive, in order to obtain the maximum benefit from its directional properties.

Reference will be made later to indoor and frame aerials, but every endeavour should be made to put up an outdoor aerial on the lines given above, on account of the better results obtainable with less apparatus.

EARTH.

The importance of a good "earth" cannot be over-estimated. It may make all the difference between excellent and merely passable results. Briefly, the wire consists of a rubber-insulated wire of at least as big a gauge as that of the aerial, connected, preferably by soldering firmly, to a

thin sheet of copper about five feet by one foot, buried say four feet in the ground, beneath the aerial, and as near the set as practicable, in order to keep down the length of the wire to about ten or fifteen feet. This insulated wire is brought up through the ground and into the set through a hole in a window or wall, or by means of a leading-in tube as in the case of the aerial.

The size of the above earth-plate can be increased with advantage, but the above was found to act well, the cost being only 5s. for copper sheeting about twice the thickness of a stout visiting card. Other metal sheets can of course be used, or even an iron pipe driven into the ground. But a proper earth-plate is worth while. The spot selected for the earth should be a moist one. Charcoal or coke may be packed around the plate to retain moisture and make good contact with the earth around, and an occasional watering of the ground above the buried plate is an advantage.

Failing an earth-plate, the wire may be taken to a leaden main water-pipe. The pipe should be sandpapered clean, and connexion made either by soldering or, more easily, by one of the special clip connexions similar to those used for radiator hose junctions in motor cars. Such an "earth" is often very efficient. Connexion should not be made to pipes which merely run to cisterns, nor to gas pipes.

Uninsulated wire *can* be used, but is not advised. A much longer wire is also practicable, but the shorter the earth lead is kept, the better. Wires should not be stapled to walls, etc.

The Receiving Set.

(1) *Crystal.*—This is the simplest form of receiver, and gives the truest rendering of the transmitted sounds. Its only drawbacks are its limited range, and the fact that it needs adjustment. The latter point has been largely eliminated by the introduction of so-called "fixed" detectors, of which there are two very good types on the market, priced at 3s. 6d. and 6s. respectively. The addition of one of these to a crystal set is worth while.

The range of a set of this description for telephony may be conservatively stated at five miles from a relay station, fifteen from a main station, and eighty from the high-power station at Daventry. Distances much in excess of these have been and frequently are covered.

Reception on a crystal set is by telephones only. This form of set is extremely simple, easy to make, or cheap to buy. It consists of a method of tuning the incoming oscillations to the appropriate wave-length, and of "rectifying" them by means of a crystal so as to make them audible in the "phones."

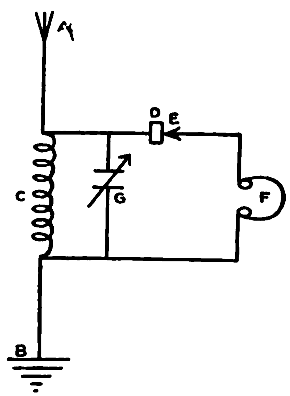
There are many crystals on the market, usually with names ending in "-ite" and consisting of synthetic galena. These are very sensitive, and readily give results when brought into light contact with the "cat's

whisker" until time, dust, oxidation, or strong currents impair their powers. The fixed detector noted above consists of two crystals of a different type, and is strongly recommended. The circuit of a simple form of crystal set is given here (fig. 1) in order to illustrate the principles on which reception is based.

Here A is the aerial, B the earth, C the tuning inductance, D the crystal, E the cat's whisker of very fine wire, F the telephones, and G the variable condenser for tuning the inductance C.

This tuning is necessary in order to bring the receiving set into resonance with the station transmitting. Theoretically the sum of the wave-lengths of the aerial system and inductance should do that, but as it is obviously inconvenient to vary these within small limits, a variable condenser is introduced to do this by adding "capacity" to the circuit.

When we say that a receiver will tune to a given range of wave-lengths —say 200 to 3,000 metres—we mean that it can be so adjusted as to receive,



at its appropriate range, signals sent out at wave-lengths within those limits. In practice, sets are commonly fitted with plug-in coils, by simply plugging in which we can vary the wave-length range within very large limits.

As has been stated, the crystal set has its limitations. It is, however, an excellent set to construct as a beginning, and can easily be put together in a couple of hours at very small cost.

(2) *Valve Sets.*—For more powerful or distant reception, and for loud speaker work, valves are necessary. These are small glass bulbs, roughly resembling small electric light bulbs, but on closer inspection it will be seen that there are material differences. It is beyond the scope of this brief note to go into the theory of wireless valves or the romance of their discovery. But one may note in passing that they act in a receiving set either as detectors or amplifiers, or both.

The range of a valve set depends on the number of valves used, the

type of circuit, and the skill with which the instrument is operated. While it is ridiculously easy to obtain results from a near-by station, the tuning-in of long-distance stations ("DX work") calls for both skill and patience if the best results are to be obtained. A single valve "reaction" set will normally cover a distance of about fifty miles on phones; with skilful handling it will cover hundreds on occasion. A two-valve set has a correspondingly bigger range—a three-valve set will cover the European stations, provided aerial, earth, and set be efficient and properly handled. On a near station two or three valves will work a loud speaker.

It is very difficult, however, to lay down any definite data as regards the distance over which a given set will operate, and a possible purchaser of a manufactured receiver is advised to have a demonstration, on his own aerial and earth if possible, of the capabilities of the set before completing the purchase.

For those with a little—a very little—constructional ability, it is quite easy to make a really good set at much less cost than to buy a similar article ready-made. The parts for many different types of sets of proven worth are available in complete kits, including even the ebonite panel ready drilled. But it is preferable to select components from among the many types available. It is satisfactory to be able to note that, at very reasonable price, the British component parts are unexcelled by any others. It is invidious to specify where so many are good, and the constructor is advised to refer to the excellent wireless papers published every week, and if in any doubt to avail themselves of the advisory services of those papers. Constructional articles often specify components by name—these will act as a guide. The truest economy will be found in the use of parts of the best quality only—the difference in price is trivial.

When buying or building a valve set, the method of lighting the filaments of the valve or valves should be considered. Valves are now made either as "bright" or "dull" emitters—that is, they give off electrons at a high or low temperature. They also vary in the voltage they require, and the current or amperage they consume. For the man with accumulator-charging facilities, bright emitters are satisfactory and cheaper to buy. Dull emitters are more economical in the long run, as they consume so much less current, and can be worked from dry batteries or accumulators. The choice of valves and their lighting should be made with care and consideration.

The high-tension battery is a factor which has given much trouble in the past. Consisting of a collection of tiny dry cells joined in series to give, say, sixty to seventy-two volts, and held in place by pitch or paraffin wax, this battery had a bad habit of adding extraneous noises. Also, if wrongly connected to the set, of burning out the filament of a valve in a flash. Now, larger batteries have much improved this component, and care in connecting up will save accidents to valves. For those who disregard expense, high tension accumulators are made. They cost about four times

as much as the high tension dry batteries, but are more reliable and probably not as expensive in the end.

There is a type of set now on the market, either ready-made or in parts, called the "Unidyne." This uses no high-tension battery. Very numerous correspondents in the wireless press have testified to the satisfactory nature of the results obtained.

The purchase of a loud speaker may well be deferred until experience has been gained in the manipulation of the set. Here, again, an actual trial should, if possible, be arranged. There are many excellent types on the market. The one you buy must be a clear speaker also. Quality and not noise is the hall mark of the loud speaker. The disc or cone-shaped pattern has lately become fashionable.

Reception on Frame and Indoor Aerials.

An indoor aerial merely consists of one in which as much as possible of about 100 feet of wire is erected within the house, as under the roof or in a room, on the same general principles as an outdoor pattern.

Many methods of doing this will occur to the mind of the experimenter. Perhaps one of the easiest is to run about six lengths of insulated wire from side to side or end to end of a room, parallel to and about a foot from each other and from the ceiling, gathering these together into a single lead at one end.

The earth connexion will probably have to be made to a water-pipe, by clip and insulated wire.

The frame aerial consists of about 100 feet of wire bound on a framework usually consisting of arms in the form of an X, the wires being supported on ebonite insulation at the ends of the arms.

The frame is turned so that its edge points at the station it is desired to receive. It is strongly directional, and if turned at right angles nothing may be heard.

Frame or indoor aerials are, generally speaking, useless for crystal sets, and if used with valve sets, more valves are necessary to attain the same results as a smaller set on an outside aerial.

There is an area—as a rule about one to two miles radius of a main broadcasting station—called a "swamping" area. Within this, very good results can be obtained on the simplest crystal set, using a wire spring mattress or frame of bedstead as aerial, and a connection to a bath tap as earth. Such results must not be taken as a measure of those likely to be obtained with indoor aerials at greater distances.

No attempt has been made to explain the theories underlying wireless reception. The above has been written merely in the hopes of interesting those who are unacquainted with broadcasting, and of inducing them to take up a most fascinating pastime, which has the additional advantage of being best experimented with after darkness has fallen and the day's work is completed.

Echoes of the Past.

AN ARMY SURGEON'S EXPERIENCES IN SOUTH AFRICA, 1843-46.

EDITED, AND WITH A FORSWORD, BY H. B. NEWHAM, C.M.G., M.D.
Late Temporary Lieutenant-Colonel, Royal Army Medical Corps.

(*Continued from p.* 311).

Hospital (Fortified) (In which I live, and,
save the Mark, Command)
Fort Beaufort
Frontier,
Southern Africa.
June 11*th*, 1846.

MY DEAR GEORGE,

I wrote a little ago to you, and this day forwarded three Papers. I would have sent them regularly, but as our Communications are nearly cut off from Grahamstown, could not.

You will, no doubt, see our affairs mentioned in the Papers at home.

Just now everything is being put in readiness for again attacking the Caffirs in their Strongholds, the Amatoli Mountains. They attacked Fort Peddie the other day, but were beaten off. My friend Maclean shot a leader of one division within about 100 yards of the Fort.

Fraser (D. J.) of whom as a friend I have so often written to you, has had two narrow escapes; one ball grazed his cheek, another brushed his elbow. He broke the fellow's leg who did the latter, but he was carried off by his comrades.

You dare not move here without an escort of Armed Men. For three weeks sleep was quite a stranger to me, or if I had any, it was to be awoke by some alarm, but now, thanks to Providence, a Man can take off his clothes.

The Caffirs used to tease us here at night by trying whether all the approaches to the Town were guarded, but have for the last fourteen days given that up.

We patrol a good deal in their Country, and have burned every hut of theirs for Miles, so that they may not have shelter.

The Cattle they have carried off from the Colonists is enormous; fancy at one Lager (Boers' Camp) taking away 21,000 sheep.

Everyone is now under Military Law; at some places the Colonists have defended themselves like Heroes.

The Boers are, I think, not generally well affected, and I think many of them are rank poltroons; but they are a large number and have to be humoured just now.

Fraser, the other day, marching from this place, happened to be separated from the main body, with 12 men and a howitzer, accompanied for protection by 30 mounted Boers. The Caffirs attacked them, the Boers leaving him and the 12 men to their fate, which is dismemberment, in case of being wounded. He opened upon the Caffirs with Canister and Shells, and after ¾ of an hour got his party clear off without a Casualty, except the touch on his Chest.

The wounded are doing well; we have had 14 of them here.

I have derived much benefit from seeing this Class of injuries, unlike every other I have seen. Books give but a very imperfect idea of what Gun Shot wounds are.

At first I had most severe work, being harassed night and day; not even a handy person to assist in putting on a bandage. But the suffering of the poor fellows stimulated to exertion, and I think nothing was left undone that their state demanded.

Now everything is in train, and ship-shape.

I got Soft Solder from the General when here for my exertions. He was greatly pleased at Dr. Forrest's report, and at seeing them himself. I must tell you I am a martinet, and I must say I feel, whether from infirmity of temper, or otherwise, that my tone is becoming dictatorial and sharp.

Fancy a man lying down with two brace of Pistols at his very Hand, or under his head, and no end of Carbines about him. This is the state of everyone here and all over the frontier.

Nearly all our people are here now, the troops being almost to a man withdrawn from Capetown.

You will see how our Boys are spoken of in the Papers I send you. We have scarcely a man in the Hospital.

Although their Picquets, Patrole, etc., would astonish you, I calculated we have from 20-30,000 men in arms against us. Every step since the commencement seems to have been fated to draw out the tribes, who still are declared "they would sit still."

It is frightful to look on both sides the border. The homes of the Colonists heaps of ashes; on the other hand the Kraals of the Caffirs in the same condition, their fences broken down, and, in fact, utter ruin.

However, they brought it on, and will, in the end, no doubt suffer frightfully, as they seem determined to fight it out. It will, I fear, be now very long before this Guerilla Warfare is over; the Caffirs will, I fancy, either retire before our troops, or try and dash into the Colony behind them.

The attack on Fort Peddie, Maclean had known from his spies days before. He is turning out as good a Magistrate and Diplomatic Agent as he

was an officer, but he must be an ornament to any situation, being a Soldier, a Gentleman, and a Scholar. I miss him very much; he and I were like brothers in every way. I think it probable that we may move in a day or two, as soon as provisions can be obtained. At present we are rather low, neither Sugar or Coffee to be had for love or money.

. . . . . .

I have had some severe losses on account of the present Confusion; and fear all my Curiosities are ruined, having to leave them behind at Cape Town.

My Nag there sold, I believe, for a song, but I have now two most sweet ones. I got a *Stick* in one on my arrival, but parted with him to Government to be used as a Bat to carry powder bags, which he will do right well. But woe betide his rider; however, they know him. He is a beautiful creature, but there is no vice ever Animal had he wants.

Having put him in good condition I got two pounds of an advance on his original price. He never got me off, but I narrowly escaped being killed twice or thrice.

I have now, I think, the prettiest, gentlest, and best Pony on frontier I bought him from the Caffirs before this blaze broke out.

My other Nag, a well-bred Chestnut, I got by chance and was to-day offered 15 pounds profit on him, but could not take it, as Good Shooting Horses are now at a premium, every man being mounted who is able; besides our friends have taken a good number over to themselves.

I have been almost alarmingly ill, being threatened with Dysentery, which is very fatal here; but, thanks to God, I am all right again.

The nights now (depth of winter) are cold and frosty; some days very hot so that sleeping in the open is not a very healthy thing. I am afraid Rheumatism will seize me as I have now to look out for it.

The Caffirs are, I believe, dying from eating such quantities of flesh without vegetables or milk, and being so much exposed. One thing is certain, that from the intense cold at nights their wounded are dying, and we frequently come upon them where they had crawled to die.

A wound which would kill a white man is nothing to one of these. They venture their own lives prodigally to carry off their wounded; and also to cut the throats of our men who fall under their fire. Dr. Bardy (asst.) just shot two fellows dismembering one of their men.

I fear it will now be long ere we get out of this Country; how annoying!

Remember me most kindly to the Governor, and tell him I hope one day perhaps to tell him of scenes foreign to those at home. But if I fall in the present struggle I hope it will be as a brave man who has done his duty faithfully to dear old England.

For the present, farewell.

W. N. Irwin.

10 *p.m.*—I shall keep this open until we move, or next post.

. . . . . .

I hear while I write this line some shots a few miles off, but this is quite common.

The Caffirs used to skirmish with our Cattle Herds nearly in range of the Guns, but got well Drilled once or twice by the Fingoes, our Allies, who are a splendid lot of fellows, and hate their former oppressors cordially.

The Cape Corps (Hottentots) fight desperately; six went with an express the other day, only two of which escaped. They fought desperately, and succeeded in making their way through a Crowd of opponents. The rascals get excited, put in too much Powder, and fire high, which is our safety.

16*th*.—Our men have been out for the last three days and are just returned, having made a demonstration so as to harass the Enemy. As to the real point of attack, the General was to have attacked the Enemy near Fort Peddie on Thursday last (14th).

They had a terrible downfall the other day there, and have lost nearly 1,000 men.

Our Forage and provisions are falling very short, and there is scarcely a pile of grass for the Cattle. Not a drop of rain, except once, for months.

Report says some of the Caffirs have sued for peace; but nothing will do except giving another good dressing, or even two; it is, after all, a most disgusting warfare.

The 7th Dragoons and Cape Corps hewed them down.

The other day, how strange, the Fingoes gave them quarter, although only a few days elapsed since some Fingoes were roasted alive by the Caffirs.

Peddie is 50 miles off, and probably Sir Peregrine will follow them up over the Keiskarina and Buffalo Rivers, where I think they are sure to retire, but this post will show, if it comes? I am getting sick of it; if I saw a stand-up fight, as at Peddie, that would be something.

Imagine a Caffir (wounded) committing suicide on the field, sooner than be taken, although they know we give them quarter. Some of them appear possessed of Devils. Two of them seized a Capt. of the Cape Corps, and were coquetting who was to stab him, having only one spear, when a Man came up, drew his (the Capt.'s) Sword, and cut one down, the other was shot by one of his own men. The Capt. had shot two a minute before, and was about reloading when he got pinioned from behind.

There are an enormous number of narrow escapes; a Common thing is a ball into your Cap, or a button cut off.

If the Post comes in I shall slip a single sheet in with the latest.

18*th June*.—No Post, or news from the other division. Artillery and 2 Guns have joined our division here. We expect to move when the supplies arrive.

We give a great dinner to-day to the Lieut.-Governor Col. Hare, who Commanded the Regt. this day 31 years.

We lost more in proportion than any Regt. in the field.

. . . . .

Camp on the Tyrunie River,
near Block Drift, Caffraria,
October 23*rd*, 1846.

George Colwey, Esqre., Winslow, Bucks, England.

My Dear George,

Time being very uncertain with me on many accounts, I take literally the first moment I have to answer your very welcome letter received last night, after a day's march, since which time we have been taking Cattle and I have only just returned after a seven hours' patrol.

The Paramount Chief Sandilla sent a message late yesterday to say he should agree to all the Governor's terms, but, unfortunately, one of the Divisions co-operating with us had not intelligence of it, and therefore killed some Caffirs this morning.

Macomo, a Chief of the Grikas, and their general and statesman has surrendered; this, I hope, puts an end to the War, the other Chiefs of the Ilambie and Congo tribes being, besides the Grikas, despicable as enemies.

The terms of our Government are giving up their guns, and the Cattle and Horses taken during the War, and moving out of the Neutral territory, viz., that between the Fish and Keskanina Rivers, and then either remaining as British subjects on the Colonial side of the Kei River, or going where they like. These are stringent but necessary.

I have not slept under a roof since the 25th of July last, when we moved into the Field. I hope since then you received my letters regularly. We have news by the Post up to 15th August, although your letter has been so unfortunate as to be dated June, and I received a letter of 19th June from my namesake at the same time, so that they happened to get on some *very* slow ship.

I am much amused at reading some of the English Papers and their remarks on this Country, and on what we are now engaged in.

I see also poor Bambricks' death given in the *Illustrated London News.* I was over the ground with our people looking for any remains of him, but found none except the Lace of his Shell Jacket. He was pursuing some Caffirs when he received his death wound by a Ball in his Chest. The enemy succeeded in carrying off his body, and, I believe, cut him into pieces while still breathing. This was the beginning of the fighting, and gave them great Confidence. I have seen many things horrible enough since then, and have had my own share of hardship and trial. I wrote to you of how narrowly I escaped twice in one day and night.

Latterly the Enemy keep a very respectful distance, but take *Pot Shots*

at you occasionally. From some of *our* late affairs I shall give you one. We found out that a nest of fellows had planted themselves in rather an open place within 6 miles of our Camp. With horses, oxen, etc., we moved at 3 a.m. without sound of Bugle, and arrived at the Kraal before Sunrise intending to surround it if possible, and take them prisoners. They, however, were alive, and tried hard to escape with Horses, but it did not answer, the Mounted Men pressed them so close that they were forced to jump off their Horses, and try to gain their Earth, namely, Bush, but failed, as three were shot while in the act of throwing assegais, or taking aim. It then became a case of (Jokking) running into Hunting Phrase. They can run and no mistake. Still trying to turn on their pursuers, but vainly, the Pace being too good, and Carbines well shotted with steady marksmen, and Horses, we went over 3 miles of Country in very quick style. A brother to the Chief (Macomo) was wounded, and, as I jumped off my horse to examine his wound he prepared himself for death most coolly, but was agreeably surprised to see me hand my Pistol to a Dragoon. We sent him in to Hospital to Fort Beaufort, where he now is.

I have seen a good deal of Wounds, and have derived great benefit from it. Camp is the place also, to learn Man, in active service ; he is so often stripped of false colouring.

A whole mob of Field Officers have arrived here, I think, a little late, and two Regts. are coming. This however will relieve us 27th, and allow us to get home sooner.

We see "Punch" occasionally; it is still admirable. Lord John and the Queen is rich. . . .

I am lately becoming rather stout, and last week found that I was too large for a tight jacket. This has succeeded to my severe illness (Dysentery) from which we suffered a good deal.

We had *five* days rain about 3 weeks ago. What would you think of that in England? Rain such as you seldom, if ever see, and honestly continued without intermission. The water broke up in our Tents, and we were forced to remain there for that time, but the Country now amply repays us for our hardship, being green and beautiful, and there is an abundant supply of grass for our starving horses, Forage having failed us.

This is our Spring, and the weather is unsettled. We had it 130 in the Tents two days ago, with a Maddening hot wind, but fortunately Thunder came on, which relieved us immediately.

I am glad the Bulbs please the Governor, as it gave me great pleasure in sending them to him, and I was anxious they should succeed.

A friend at Natal promises to send me some Bulbs, probably never before seen by a white man, from the Far Interior. He has the chance from his Diplomatic relations as Agent with the tribes there.

I should inform you that the Chief Macomo is now a patient of mine, and will, I hope, come in on Monday next for treatment. At a meeting the other day he was very glad to see me, and begged our Colonel

(Johnstone) to allow me to meet him. This will have a good effect as he is by far the Cleverest of them, and could run round any of our Diplomats here in no time. They are certainly a noble, though savage race, their individual bravery I have seen tried amid showers of Bullets.

Our Colonel still commands this Division of the Army in the Field and I am still the Senior in Charge. Delmege's promotion merely gives me seniority in the Regt., and having Charge in the Field 2s. 3d. a day Field Allowance.

I was offered money to exchange on the Staff, and remain here, but declined, as I have a hankering after seeing England.

The appointment of Surgeons to the Reserve Battalions of Regts. brings us up a little, and we may now expect promotion after nine Yrs. Service, to the Rank of Surgeons.

Whether this War will be considered by the War Office as a reason to give us it before others remains to be seen; perhaps you are not aware that we are generally promoted by Seniority, but of course Kissing goes by favour even in these Cases. One getting a good station or Regt. and another a bad one. So far I am content, I have only been Wigged since the commencement of the War for being what was considered too close to the front. Anxious to be near in the Work, it is, to me, rather more exciting than a Hunt, not but that the Leaden Messengers are unpleasant music, and the Collapse after the business not agreeable. Men you saw in the pride of Life, lying stretched, or writhing in *Agony*. This at first gives you a qualmishness, but this you learn to *suppress*. What Bullied me more than all was firing into the Camp at night. This they some time since gave up.

Now for domestic Life. I am really happy to hear of all your welfare. No time or circumstance changeth the true heart; and the memory of all your kindness is most agreeable to me, particularly after passing through the harrowing scenes War in any form is sure to present.

. . . .

My old friend, Mrs. MacLean, and her Husband, still continue their affection to me. He is getting on very well in his new Situation, and she appears quite happy in her family.

Any spare female affection I have is therefore thrown to her, and in return she cares for me as an attached sister.

I shall be able perhaps one day to show her likeness, a poor one I confess, but just sufficient to give you an idea of a Noble Christian, which she really is.

. . . .

Tell all the girls how much and how often I think of them. Ask Emily does she remember the morning we left for London, and to the rest how much I value their useful presents, which I religiously take care of.

Instead of the little black Angel I promised Charlotte I shall likely procure the likeness of some of the Chiefs, painted by my excellent and sweet friend, Mrs. Johnstone, our Colonel's Lady, who is a sweet hand at Portraits.

I suppose Rose has grown quite a fine woman, and scarcely amid the pleasures of Norfolk remembers an old friend. However this may be, remember me most kindly to her; she promised to be a very fine Creation, and you know, I think I am a Judge in such matters. I remember your estimate of Irishmen in these cases, but you do not judge us fairly. Some of even *our own* 27th fellows thought me cool enough, while at parties at Government House, Capetown, parading the Miss Maitlands about.

But I had my revenge in the remarks of the Ladies upon the want of gallantry in some of my Superiors.

We move, I believe, to the Amatoli Flats to-morrow. Close by their Mountain fastnesses, I forgot to mention, that where we are now encamped, about 300 Caffirs fell at the attack on Colonel Somerset's Division. Shell and Canister cleared them off, or from their enormous numbers, they should have crushed our small forces.

Remember me most kindly to all my Winslow friends, whose kindness I am not likely to forget. It does touch a fellow "*on the Raw*" to find himself not forgotten when far away.

. . . .

I read the Mission in January last at Capetown, and do not remember anything overdrawn. Our Headquarters division went along the very line he feigns to travel, and I know some of Bess's descendants, who claim a relationship with the White Man on that account, and who, among the tribes are esteemed brave.

If I happen to meet it again I shall jot off any inaccuracies. It is well adapted for young people, but a man to write a genuine history of the tribes, their customs, etc., would be scouted at home. I shall one day give you tangible proof of some things you would not credit, otherwise.

As regards myself, I wear a long beard, and am rather burnt with a little more soberness of manner about me. Live Temperately, and sometimes have to smoke to serve for a meal. Thanks to God, no more horrid thirst for a time, at least; you know not that pang.

We have in Camp with us part of the 90th Regt. Artillery, some Dragoon Guards, and Cape Rifles, with Fingoes, Hottentots, etc.; all are now soldiers, or liable to serve.

I feel changes of weather since my illness, but hope to get well through, and safe home.

Distress is severely felt by both Colonists and Caffirs, and I shall be quite willing to get away when the lull arrives, as the General has orders to send us home as soon as he can spare us.

Johnstone went over the Kei to the Chief Krieli Country with a part of

ours, a severe thing, and I think our fellows require some rest now, most of them being Old Soldiers.

I shall not close this until an express goes for the Colony.

Believe me as ever, sincerely,

W. N. Irwin.

Noon 24th October.—Heavy rain detains us to-day, odd Caffirs coming in to tender their submission. Tell Irwin I shall write to him by next Post, Deo Voleat.

This is an interesting time, but we shall have severe duties yet, in finding out nests of Banditti and breaking them up, no easy task, I can assure you. In the affair I have related the other day we took 150 Cows and Oxen, and 40 Horses, and yesterday 300 Oxen and 40 Horses.

I have hopes Macomo will get me my charger again, if they have not ridden him to death. They ride well and sit like a piece of the Animal.

Travel.

NOTES ON KHAIRAGALI AND CHANGLIGALI, NORTH-WEST FRONTIER PROVINCE.

By Major J. E. M. BOYD, M.C., F.E.S.
Royal Army Medical Corps.

As there is only one medical officer appointed to these two stations, it may be as well to describe them together, as far as this is possible.

Both are situated, about two and a half miles apart, in the Abbotabad area of the Hazara District, North-West Frontier Province, and about eight and ten and a half miles respectively from Murree.

The height above sea level of Khairagali is 7,678 feet, and of Changligali 8,420, so that the walk from one station to the other is, to say the least, somewhat trying.

The accommodation at Khairagali is for one Pack Battery and about twenty married families; the latter live in two-storied quarters at the foot of the hill, on the Murree side of the station, the former in single-storied buildings on top of the hill.

Changligali has no troops stationed there, except a section of drivers of the I.A.S.C. who are employed in the distribution of meat and bread from the Government butchery and bakery to neighbouring stations which lie on a spur about five hundred feet below Changligali, where in the hot weather there is a School of Instruction for the I.A.S.C. attended by about twenty officers of that unit.

New arrivals at these stations may, at first, experience some delay in

receiving their letters, owing to the many ways in which the names are spelt.

The hospital accommodation at Khairagali consists of a five-bedded section hospital, where cases may be detained for forty-eight hours; any cases requiring admission have to be sent to the British Station Hospital, Barian, which is about a mile and a half away, on the Murree side of the station. This refers to British troops.

For Indian troops and followers there is a ten-bedded Indian Station Hospital, consisting of one large ward and two single-bedded wards, one of which is used as a surgery and the other for either Indian officers or infectious cases.

There are, in addition, the usual outhouses for the use of patients, British and Indian, and a separate block at a lower level, used as a dispensary and office.

The staff of these hospitals consists of 1 medical officer, R.A.M.C., 1 assistant surgeon, 1 sub-assistant surgeon, 4 ambulance orderlies and the usual other branches of the I.H.C.

There is no charge pay for the medical officer, but as he also commands an I.S.H. he is entitled to I.M.S. rates of pay, which, in the case of a Major, R.A.M.C., amounts to an additional 100 rupees each month.

At Changligali there is no form of hospital or medical assistance; severe cases have to be seen up there by the medical officer from Khairagali, mild cases come down to see him. Cases requiring hospital treatment are sent either to the B.S.H., Barian, or to the I.S.H., Khairagali.

The first point of interest to those posted to these stations is how to reach them. Railhead is at Rawalpindi, whence one is taken to Murree by car. It is best to wait until one reaches Rawalpindi to hire a car and not to write in advance, as there are many agents there and they bid, one against the other, for the honour of driving officers up the hill; in this way one may save quite a number of rupees. The average cost for a whole car is 35 rupees. Heavy luggage costs about 2 rupees per maund up to Murree by lorry. It is well, if possible, to see your heavy luggage leave Rawalpindi, as truthfulness is not a strong point with the agents, and although they promise to send it off "at once," this promise is liable to be overlooked. It is well, also, to send your servants in the same lorry as the luggage, to prevent loss.

Before leaving Rawalpindi try to obtain a pass, showing that you are travelling on duty, otherwise a toll of a rupee, 1s. 8d., is levied on each car on the road.

On arriving at Sunnybank, Murree, ponies or dandies are hired to complete the journey; a pony costs 2 rupees and a dandy 7 rupees. Light luggage, bedding, etc., is carried by coolies, 12 annas each, and heavy luggage in bullock carts, which cost about 7 to 8 rupees each. These prices are, I think, rather in excess of the normal, but I was new to the district so had to rely on the coolie agent for rates and fancy he put on a few annas in each case.

Never leave your bedding behind, for if you do so you may experience considerable discomfort.

There is a medical officer's bungalow at Khairagali, for which one pays 55 rupees a month; as there are only three rooms I consider that the rent is excessive, especially as the position of the house renders it unsuitable in every way. The rooms are arranged in the form of a squat "T," one in front and two behind. The front room, which we used as a combined drawing and sitting-room, overlooks the only tennis court, and as soon as play commences a dark screen is put up, which shuts out most of the light from the only window not shaded and darkened by a verandah. On Thursdays and Sundays, if fine, the screen is usually put up about 9·30 a.m. and remains up all day. Officers use the court on two days of the week, British soldiers using it on the other days, so that there was usually considerable noise, the more so when the children accompanied their mothers; the noise was then sometimes hard to bear.

The second room, which I used as a study and dressing-room, was overlooked by a road, and everyone passing seemed to take a great interest in what was going on in the room.

The third room, used as a bedroom, was the only convenient room in the house, and overlooked the valley.

There were two bathrooms, about six feet square, off the two back rooms and one small store room, but as lamps, oil, etc., had to be kept there, as well as the china, it was useless for storing tea, sugar and other eatables, owing to the pilfering which went on.

Furniture is hired from the Barrack Master and costs 5 rupees a month; there is quite enough for the rooms, one easy chair only is provided and no baths; on arrival we had to borrow two round barrack baths which were decidedly uncomfortable.

It is difficult to realize how a married officer, with growing children and perhaps an English nurse, could manage to fit himself and his family into so small a building.

As regards servants, only sweepers, bhisties, etc., are obtainable; it is therefore necessary to bring up your khansama, bearer and khitmagar from the plains. Dhobis are indifferent, impertinent and expensive.

Supplies can be obtained, but not in any variety. Bread is made at the bakery at Changligali and can be obtained from the ration stand. Throughout the season it has been of excellent quality and by far the best we have ever received in India; meat can also be obtained from the contractor at the ration stand; beef can only be obtained in this way. There was a mutton shop in the bazaar where excellent mutton could be obtained.

Fowls and eggs could at times be bought locally, but were usually cornered by the Army Canteen Board; the best way to get these was to make friends with one of the Forest Department men, who would collect them from villages he visited when out in the jungle.

Fruit and vegetables were not plentiful, nor was there much variety

The Army Canteen Board subcontractor had a tent in the lines, but as he had to pay the local contractor 50 rupees a month for his licence, his prices were high and the cost of his licence came out of the pockets of his customers. There was a fruit-seller in the bazaar, but as he was not allowed to sell in barracks his trade was so small that he closed down his shop and left the station. Excellent fruit could be obtained at Barian at much cheaper rates than at Khairagali.

Tinned stores could sometimes be obtained at the coffee shop in the lines, under the management of the Army Canteen Board, but this was a broken reed on which to lean, as the stock was always deficient of anything one wanted, in spite of the lengthy price list issued. There was, however, a man in the bazaar who had a tea shop for the troops; he had a small stock and was always willing to send into Murree for anything he had not got.

Butter and milk were procurable from the Government dairy at Barian; there were also local milkmen; the milk supplied by the latter was good, provided that the cow was brought to the door, but the butter was the most unpleasant mixture I have seen for some time. Luckily the troops were not allowed to buy this, if they had done so cases of the enteric group would have been many.

Beer came from the Murree Brewery and minerals from the Army Canteen Board factory at Barian.

Water is brought in from near Dunga Gali, about ten miles away, by means of pipes, along a road which is practically flat the whole way, a really excellent piece of engineering work, but it has to be distributed by means of packals, carried on mules, the level of the pipe-line being below that of the cantonment. The water is fit for drinking, unboiled, but the filling of the packals by Indians is a weak point, and it is a pity that a pumping station cannot be installed, so as to allow of a stand-pipe distribution.

The climatic conditions are at times unpleasant, as the rains are heavy. The average rainfall is about sixty inches, mostly during the monsoon. A rain gauge was fixed at Changligali about the middle of June this year. July was the worst month, with a total of 27·73 inches, the highest daily records for the month being 4·92 inches on the 21st, 4·73 inches on the 23rd, and 3·20 inches on the 26th.

Wet and inclement days during each month were as follows: May 20, June 14, July 31, August 21 and, up to to-day, September 20.

Both winter and summer clothing are required, we left the plains when the shade temperature was 107° and the day after our arrival the thermometer in the office never rose above 44°.

The lowest and highest readings, in the M.O.'s office, at 9 a.m. have been as follows: May, 48°, 78°; June, 66°, 72°; July, 64°, 72°; August, 58°, 72°, and September, to date, 62°, 72°. There have been several thunder-storms this month with hail, and the evenings are chilly and fires necessary.

Sport is hard to obtain; there is tennis for officers twice a week and some hockey with the battery teams. We occasionally hear of a stray leopard, but not one has been shot; there are said to be a few chickor on Changligali and in the valleys, but I have not been fit enough to verify this, nor have any been shot by the other officers.

British soldiers have shot a few jackals, and a few days ago I met a soldier with what had once been two doves and a green pigeon which, judging from their mangled condition, had been shot at very close range.

The social side of life has not been very exciting, as there have only been the officers of the battery and never more than two ladies in the station throughout the season. There is no club, no dancing, except the weekly dance for the British soldiers, no cinema nearer than Murree, and few evening entertainments, so life has been one long period of peace and quietness.

There are very fine views of the snowy Kashmir hills to be had early in the season, and also "after the rains," whenever that may be. The hills are wild and mostly covered with forest; flowers, however, are not plentiful.

As regards wild fauna, there are few mammals, but since the district lies in the line of migration, many strange and beautiful birds have been seen; snakes are not common, two vipers have been killed and two large grass-snakes seen. Scorpions are fairly common but apparently peaceful, no case of scorpion sting having been reported. Many very beautiful butterflies and moths have been caught.

Medical entomology is not important; there are no anophelines, culicines are scarce. In July many sandflies, *P. minutus* var. *montanus*, were caught and also a few *Tabanidæ*. The housefly group is not well represented: few *Musca*, *Calliphora* and *Lucilia* have been seen and only one specimen of *Stomoxys*.

Lice are found at times on the Indian soldiers and followers, dogs are heavily infested with *Ctenophalus canis* during the rains, but *Pulex* is rare. Bugs are common, especially in the married quarters, and were common in the M.O.'s quarters on arrival, but free use of paraffin oil soon cleared them out. Strangely enough, only *Cimex lectularius*, and not *C. rotundatis*, was found.

These notes are rather "scrappy," but it is hoped that they may prove interesting and useful to any member of the Corps who may be posted to this pleasant if rather sleepy station of Khairagali.

Review.

FRENCH MILITARY ORGANIZATION AND MODERN FRENCH-ENGLISH MILITARY TERMS. By Jean Psomades. London: Librairie Hachette. 1926. Pp. 91. Price 4s.

This little volume is written for the benefit of candidates taking up French for the Staff College and Interpretership examinations, and in this respect has a certain amount of value for officers of the Royal Army Medical Corps, who, in the interpretership examinations, are often puzzled by words and phrases connected with the parts of rifles, guns and other armaments. An account is given of the various formations and units in French Army Organization, with the French and English equivalent terms for each. The British Organization is also explained, using the French language for the purpose, a method which will be found advantageous in translating English military sentences into French.

Unfortunately medical services receive only the briefest notice, and the translation given of *Le service de santé* is the three letters A.M.C., which scarcely indicates the English equivalent. Again, in the vocabulary of modern military terms, only nineteen terms are given under the heading of Army Medical Service. The French *l'ambulance chirurgicale automobile*, the well-known *autochir* of the war, is translated "motor surgery." A more correct translation would be "mobile operating centre." *Médecin-major* is translated as surgeon, whereas it is the French rank of majors and captains in the R.A.M.C. *Le poste de secours* is called "first-aid station" instead of "regimental aid-post." It would also have been more correct to give the heads of the medical services of field formations their English equivalent of D.M.S., D.D.M.S., A.D.M.S., and Officer Commanding a unit of the R.A.M.C., instead of giving English terms similar to the French. For example, *médecin inspecteur général* has been given the British equivalent of Director of Army Corps Medical Service, ranking as Major-General, and so on. In these respects M. Psomade's book is not altogether satisfactory, though its arrangement may be found handier than the well-known dictionary of English and French military terms, by M. Barrère. Although it can scarcely be said to take the place of M. Barrère's volume, it has the advantage of offering to the student much fewer words to memorize.

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OLD-TIME TYPHUS IN BRITAIN.[1]

By Lieutenant-Colonel W. P. MAC ARTHUR, D.S.O., M.D.
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Before touching on the history of typhus fever, one might mention some of the characteristics of lice which are either of general interest, or which affect their carriage of disease. I am advised that some such preliminary explanation might make my address more intelligible to non-medical members of the audience. The head louse and body louse of man are variants of one species, the former representing the original stock from which the body louse branched off when mankind commenced to wear clothing. The division has progressed so far that these two sub-species show certain differences in structure, the most obvious of which is the more slender antennæ of the body louse, the third segment being distinctly longer than it is broad, a disproportion in shape not shown by the head louse; the latter is also the more delicate, and its bite less irritating. On my wrist I have had resident for some days past a tribe of head lice, their bites being very obvious to you all, yet I am barely conscious of these lesions, whereas the bites of an equal number of body lice would cause me considerable discomfort.

These insects are parasites in the strictest sense, and at no stage do they lead an independent existence, unlike all other insects which prey on man. Separated from their host, they wander about in a blundering, aimless

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fashion, and unless they secure another host—seemingly more by accident than design—they surely perish; like a sunken ship's crew clinging to wreckage in mid-ocean, unless rescued they cannot hope to survive. They jump not, neither do they fly—though young forms occasionally may be carried for short distances by wind—and so they are transmitted by actual contact with the host or his clothing. "'Tis a familiar beast to man," says Shakespeare, "and signifies love." But given the necessary contact, the familiar beast can transfer himself with surprising rapidity. I remember a small boy abroad who one day was lost for several hours: finally a distracted nurse discovered him rolling about quite happily with some desperately filthy children. Knowing what to expect, she carried him home at arms' length and plunged him into a hot bath, and from the head and clothing of the child there were retrieved 145 lice!

They thrive best at a temperature a little less than that of the body, that is, the degree of heat which they experience normally in the hair and clothing. If the host should develop a fever, the lice become restless, tending to withdraw from the surface of the body and, given an opportunity, they will migrate. So that a person ill with typhus fever transmits his vermin more readily than otherwise he would. Whence the high degree of typhus-infectivity associated with beds and bedding, recognised for centuries. Some of the old Irish chroniclers, in recording the ravages of plague, small-pox, and the like, include amongst the prevalent epidemics the curiously-named distemper, *galar na leaptha*,[1] that is, the disease of the bed, which I interpret as typhus fever.

Similarly, if the host's temperature falls the lice become uneasy and temporarily very active, and a person recently dead may be seen to swarm with vermin which were nowise in evidence during life. Thomas à Becket was murdered in Canterbury Cathedral on the evening of 29th December, 4th January by our calendar. The body lay in the Cathedral all night, and next day, after some debate, it was decided to remove the clothing in preparation for burial. The dead Archbishop was clad in an extraordinary accumulation of garments. Outermost there was a large brown mantle; next, a white surplice; underneath this, a fur coat of lamb's wool; then, a woollen pelisse; then, another woollen pelisse; below this, the black cowled robe of the Benedictine order; then, a shirt; and finally, next to the body, a tightly-fitting suit of coarse hair-cloth covered on the outside with linen, the first of its kind seen in England. The innumerable vermin which had infested the dead prelate were stimulated to such activity by the cold, that his hair-cloth garment, in the words of a chronicler, "boiled over with them like water in a simmering caldron," and the onlookers "burst into alternate fits of weeping and laughter, between the sorrow of having lost such a head, and the joy of having found such a saint."

Louse eggs are firmly attached to the hair, or to threads of fabric, by a

[1] "*Pláidh coitchend ocus galar brec, ocus pláigh bhuindech ocus galar na leaptha.*"

tiny drop of cement, of such a composition as to be absolutely indissoluble; substances reputed to dissolve the cement merely affect the hair so that the egg slips more easily along the shaft. The egg is fitted with a cap at one end, pierced by holes, and NUTTALL has observed that the young louse emerges from the egg by drawing air through these holes, swallowing it, and ejecting it from the intestine; as the pressure of this compressed air increases, the young louse is propelled gently forwards, knocking off the egg-cap, and so emerges. Whence in lousing operations the great utility of treating the head with oily preparations which block the air holes and so prevent the young louse from escaping.

In possible cases of typhus or relapsing fever, it is sometimes important to determine whether or not the subject is verminous; consequently we should realise that a recently-acquired infestation with head lice may be exceedingly difficult to detect. I should refuse to believe that a suspected person is necessarily free from vermin unless his head had been gone over systematically with a fine-toothed comb. I can recall such instances when I searched very carefully with an ordinary comb and brush, making successive parallel divisions in the hair and examining the head in this way several times, without result. Then on fine-combing the head I have recovered as many as nineteen adult lice.

In old times, most of the lousing methods employed today were in use—dry heat, moist heat, fumigation with sulphur, and so forth—sometimes employed with curious additions. Thus, "For to distrie lies þat [that] ben engendrid of corrupt humouris," *The Book of Quinte Essence* advises us to take "a litil quantite of Mer[curie] and mortifie it wiþ [with] fastynge spotil."[1] Another treatment, which must have enjoyed wide popularity, is for the infested person to "take oure 5 essence bi him silf a-loone"—*i.e.*, alcohol neat—" and vse to drynke þereof [thereof] a litil quantitie at oonys." Thereupon, presumably, the vermin relaxed their hold, and fell swooning to the ground, which suggests that the mediæval quinte essence had some of the potent properties of Prohibition whiskey. A foot-note on the same page sums up the principles of lousing in one sentence, which I do not think even our learned PRESIDENT could improve on today, backed by all the accumulated experience of the intervening 500 years: "To withdryue them / The best is for to wasshe the oftentimes and to chaunge oftentymes clene lynen."

With these preliminary remarks, I come to my subject proper. Down through the centuries, typhus fever does not leave the clear trail discernible in the wake of the epidemics of plague, doubtless because the symptomatology of the disease includes no feature as arresting and distinctive as the plague bubo. Shakespeare, who shows so striking a knowledge of plague, makes no mention of the symptoms of typhus, and indeed I know of only one reference to the disease in the plays. This is where Macbeth declares that his castle is impregnable to assault, and adds, regarding the besiegers

[1] *i.e.*, fasting spittle.

beyond the walls, "There let them lie, Till famine and the ague eat them up." Originally the word ague had no connexion with chills and rigors, but signified fever, and is found in translations as the English equivalent of the Greco-Latin, *synochus*. In Elizabethan times, the word was often applied to typhus, a sense surviving in Ireland for another two hundred years. Shakespeare's conjunction of famine and ague makes my interpretation all the more likely, for, in mediæval times and later, famine and typhus were invariable concomitants, and the poet must have heard of many an army, first prostrated by famine, and then devoured by the spotted ague.

The name typhus for this disease was introduced only in the middle of the 18th century, though the word itself was of ancient origin as signifying stupor or coma, but without restriction to any particular disease.

The earliest description of this infection which is clearly identifiable without question or argument is found only about the year 1500, but centuries earlier we have records of the great famine-fevers universal throughout England, where there was always the same sequence of events, failure of the crops, famine and fever. *The Anglo-Saxon Chronicle*, in its brief notice of the great famine of 1087, says, "such a malady came on mankind that almost every other person was in the worst evil, that is, with fever." The chronicler does not attach any definitive label to the pestilence, the least general of the several terms he employs being the word *drif*, that is, the fever.

Of the famine that devastated England and France in 1196, William of Newburgh says in his chronicle, that the hand of God was lifted against the people of Christendom. Protesting that he speaks of what he knows, and testifies of what he has seen, he describes how the bodies of those dead of hunger corrupted the air, thereby causing a most raging pestilence which did not spare even the opulent, and for the destitute cut short the long torment of hunger. He says that the fever "which is called the ague" (*quae acuta dicitur*), crept about, seizing so many in the course of a single day that barely sufficient people were found to minister to the sick, or to bury the dead. The customary funeral ceremonies were abandoned, he says, and deep trenches dug to receive the bodies, because of the great multitude of the dead.

I do not propose to weary my audience with descriptions of the universal famine-fevers of 1258, 1315, and so on, for these differ in no material respect from William of Newburgh's account of the famine-fever of 1196.

These old pestilences are described in terms too general to allow of any positive identification, but the circumstances of their incidence and spread are exactly those of the less intense famine-fevers general in England during the 17th and 18th Centuries, where we know quite definitely in each instance that the accompanying fever was in the main typhus, and I have no doubt that the earlier pestilences, definitely associated with famine, were the same disease.

About a century before the first recognisable clinical description of typhus, we find records of a distemper associated with gaols. In the *Survey of London*, under the year 1414, Stow notes that "the gaolers of Newgate and Ludgate died, and prisoners in Newgate to the number of sixty-four." Five years later, an ordinance of Henry V. abolishes the debtors' prison of Ludgate, and directs the removal of the prisoners to Newgate. Later in the year, another ordinance re-establishes the Ludgate prison, because so many of the transferred prisoners were already dead "by reason of the fetid and corrupt atmosphere that is in the hateful gaol of Neugate." We cannot doubt that the gaols from the time of their establishment were hot-beds of typhus, and indeed from the accounts given by John Howard, and the earlier Oglethorpe Committee, we could almost imagine that the prisons of England were designed solely for the propagation of this disease. The great philanthropist John Howard, who himself died of typhus fever, was appointed High Sheriff of Bedfordshire in 1773 and, when his proposal to replace the gaolers' fees in Bedford by fixed salaries was rejected, for want of a precedent, he visited several other prisons in the hope of finding the precedent required. He was so moved by the horrors there witnessed, that he determined to continue his itinerary throughout the country, finally embodying the ghastly details of his inquisition in the well-known *State of the Prisons in England and Wales*. The whole prison system was rotten from top to bottom. Some gaols were private property, rented by the gaolers, who reimbursed themselves by fees exacted from the wretched prisoners and their friends, and even in the state institutions the gaolers adopted the same means of livelihood. In defiance of the law, prisoners were loaded with chains so that gaolers could extort bribes for "easement of irons," and even those found not guilty on trial were returned to prison until all the gaolers' charges had been met. The prisons were scandalously overcrowded and indescribably filthy; the gaolers escaped liability for the window tax by the simple expedient of building up the windows. In some prisons there was absolutely no provision for what, euphemistically, we call "sanitation." Some had no water supply, in others, where a well was provided within the walls, the prisoners had no access to it as they were kept continuously under lock and key. Many of the cells were underground dungeons, without light, heat, or bedding, the starving prisoners huddling together for warmth on bundles of filthy rags and rotten straw. In Plymouth Town Gaol three men were confined for two months in a tiny cell measuring 15 ft. by 8 ft., and so low that even a short man could not stand upright, the only provision for light and air being a small grating in the door measuring 7 in. by 5 in. The three men took turns in standing by the grating in order to breathe. When Howard visited this gaol there was only one occupant of this cell, but the door had not been opened for the preceding five weeks. In another gaol, a room measuring 22 ft. by 20 ft. sometimes held as many as sixty or seventy prisoners. Many gaolers refused to accompany Howard into the cells because of the gaol fever

raging there, and at Exeter the prison surgeon was exempted by the terms of his contract from attending prisoners in the dungeons suffering from gaol fever. Howard states that often after visiting a prison his clothing emitted so vile a stench that he found it impossible to remain in his closed coach, and was forced to travel on horseback, and that even the flask of vinegar which he carried with him, as a disinfectant, became intolerably offensive. And we must remember that many of the wretches rotting in these dens were untried prisoners, possibly innocent, who sometimes lay so long in prison that when at last they were brought to trial all the witnesses had been lost track of or were dead. It sometimes happened that untried prisoners, after years of hope deferred, in the end would be carried into court and propped up in the dock, dying on their feet of gaol fever. I like to imagine one or these, crying out like the blinded Samson, "Remember me I pray thee, and strengthen me this once, that I may be avenged." And if his prayer were heard, there might result one of the Black Assizes which are still remembered, if only in the etiquette of the court. The more notable of these were, the Black Assize of Cambridge, in 1522; Oxford, in 1577; Exeter, in 1589; Taunton, in 1730; and the Old Bailey, in 1750; and no account of typhus in its historical aspect could omit mentioning several of these.

In 1577 there lived in Oxford a certain Roman Catholic bookbinder named Rowland Jencks, variously described as a worthy man, or as a popish recusant, according to the opinions of the writer. In Anthony à Wood's phraseology, Jencks made it his "chief employment to vilify that Government now settled, profane God's Word, speak evilly of the Ministers, and absent himself from Church." To put an end to this scandal, the University took cognisance of Jencks and his actions, and a convocation held on 1st May, ordered him to be arrested and conveyed to London, for examination by the Chancellor of the University and others concerning his crimes. He was returned to Oxford, and committed to prison, to stand his trial at the forthcoming assizes. These began on 4th July, and a few days earlier we find the ominous record that several of the prisoners in Oxford Gaol had died in their chains. Owing to the interest taken in Jencks' case, the court was crowded, and before a large assemblage he was arraigned, and condemned to have his ears struck off, a sentence duly put into execution. Following the assizes, gaol fever broke out amongst those who had been present in the court. The judges, Sir Robert Bell the Lord Chief Baron, and Sir Nicholas Barham, "stiff enemies to the R. Cath. Religion," both died. So did the Sheriff, the Under-Sheriff, six Justices of the Peace, and all the members of the Grand Jury except one or two. Within twelve days 100 members of the University died, not a College or Hall escaping. The total recorded death-roll amounted to 510. So long as gaol fever remained decently in its proper place within the prisons, it mattered little; but when it stretched out its grisly fingers and dragged judges and other dignitaries off the bench, that was quite another affair, and the Black Assize

of Oxford created much stir. The author of a black-letter poem with the cheery title, *the doleful Dance and Song of Death*, seizes the opportunity of pointing a moral, and puts into the mouth of Death these lines:—

> "Think you on the solemn Sizes past,
> How suddenly in Oxfordshire
> I came, and made the Judges all agast,
> And Justices that did appear;
> And took both Bell and Barham away,
> And many a worthy man that day,
> And all their bodies brought to clay."

Even Francis Bacon found time to scrutinise the evidence, tearing himself away from his labours in composing Hamlet and Macbeth, the Canterbury Tales, and the Psalms of David. Strangely enough, he does not father his findings on some doctor of physic, but prints them boldly under his own name! He holds the smell of the gaol entirely responsible, but hastens to point out that it is "not those stinks which the nostrils straight abhor . . . that are most pernicious, but such airs which have some similitude with man's body, and so insinuate themselves and betray the Spirits."

This was the opinion generally held, and it led to the easy acceptance of the legend, recorded by Stow and others, that the stench of the prisoners was so overpowering that the judges succumbed, then and there, on the bench. But there were other explanations, where the close observer might detect some hint of sectarian prejudice. In the theory of one party the tragedy was a judgment from God on a schismatic and heretical court. The opposition contended that the whole affair had been devised by the Roman Catholics "who used the Art Magick in the design," and that in hellish Louvain they had compounded diabolical and utterly Papistical blasts (*diabolicis et plane papisticis flatibus*), which were secretly conveyed to Oxford, and let loose there. Without enquiring into these questions of higher chemistry, it is interesting to speculate regarding the probable method of spread. The prisoners who were presumably responsible for the outbreak could hardly have harboured sufficient lice to infect 510 fatal cases, to say nothing of those who recovered. So it would appear that the members of the University of Oxford cannot be held free from suspicion of being themselves verminous! I remember reading a letter written by a patriotic old English lady who disapproved heartily of the accession of James VI of Scotland to the English throne; in this letter she says in effect, that she had attended Queen Elizabeth's court for years and never saw a single louse there, but that since King James and the Scottish lords had come to London, she could not go near the court without becoming infested. It is a pity that she did not extend her observations to the Universities. But even the most Johnsonian of Englishmen could hardly hold the Scottish lords responsible for the Black Assize of Oxford—Papistical winds might blow thither from Louvain, but Calvinistic lice from Edinburgh would be more difficult of transmission. One might add that

after his sentence had been put into execution, Rowland Jencks, the innocent cause of all this catastrophe, departed for Douai where he became baker to the English College of Seculars; he attained a ripe old age, and was still alive thirty-three years after the tragedy.

The Black Assize of Exeter, twelve years later, resembled in its main features the Oxford outbreak; there was the same death roll of judges, knights of the shire, landed gentlemen and others of less note, but here we are given the interesting information that some of the prisoners for trial were so ill that they were helped into court, leaning on two attendants, or

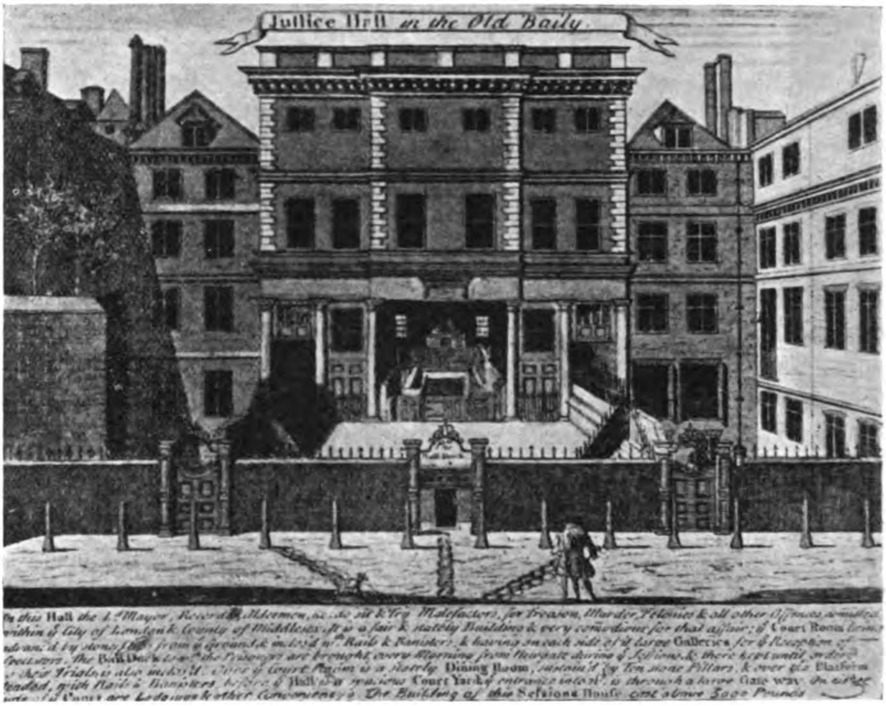

Fig. 1.—The Justice Hall, the Old Bailey, at the period of the Black Assizes.

were carried in on stretchers. Further, the epidemic spread over Devonshire, and was still raging there six months later.

The resulting sequence of events makes it necessary to speak of the Black Assizes at the Old Bailey in 1750. At the May sessions that year there was an unusually large number of prisoners for trial, about 100, and owing to the interest taken in the case of a Captain Clarke, who was tried for murder in that he had shot dead his opponent in a duel, the court was crowded. Ten days later, gaol fever broke out, and the distribution of the cases was very peculiar, as practically only those who had occupied the left side of the court were affected.

The two lantern slides (figs. 1 and 2) show the Old Bailey as it was at

this period, though the original prints were not designed to illustrate the Black Assize. In the first you see the bail-dock, where the prisoners for trial were brought each morning, with the court-room opening off the back. The second gives a view of the interior of the court-room; the dejected-looking figure with gyves upon his wrist—perhaps he has just looked out of the window on the judges' left—is, of course, the prisoner; beside him is a witness. Standing and examining the witness is the prosecuting counsel—prisoners at this period had to conduct their own defence. The judges, and the court officials on a lower level, are easily identifiable; on either side

FIG. 2.—The Interior of the Court-Room, the Old Bailey, at the period of the Black Assizes.

we see the jury in their box, and around the dock, counsel and other lawyers. Members of the public occupy the galleries. During the fatal assizes, the Bench consisted of six persons; the Lord Mayor, Sir Samuel Pennant, sat as nearly as possible in the middle, with Lee the Lord Chief Justice, and the Recorder of London, on his right; on his left were Baron Clark, Sir Thomas Abney another Judge, and Sir Daniel Lambert an Alderman and Justice. On the right of the court was the London jury, and the Middlesex jury on the left. Of those on the bench, the two on the Lord Mayor's right escaped; the Lord Mayor himself, Baron Clark,

Sir Thomas Abney, and Sir Daniel Lambert, all died. None of the London jury on the right of the court was affected; of the Middlesex jury on the left, all died except four; and of the under-sheriffs, barristers and others, to the number of over forty who died, practically all were on the left of the court. At this interval, one cannot do more than suggest a reason for the strange distribution, for the determining factor has remained unrecorded. Possibly the public gallery on the judges' left held some person who harboured infected lice; the court was excessively hot, as we know, and he may well have removed his wig and some of his clothing, and in this way have shed a rain of infected lice on the people below. Those insects falling on the benches would wander about, and, as lice do, seize hold of any fabric which brushed against them, and soon penetrate hence to the wearer's body.

Alarmed at the ravages of a distemper which spared neither Lord Mayor nor Aldermen, the Corporation of London appointed a committee to consider the best means of preventing such outbreaks. The committee, on the advice of Hales, the physicist, and [Sir John] Pringle, decided that lack of ventilation alone was responsible, and they proposed the erection of a windmill-like device on the roof of Newgate to abstract the foul air from the cells. This ingenious and complicated apparatus will be found fully described and figured in the *Gentleman's Magazine* for 1752. The Corporation approved the scheme, but delayed its execution until another Lord Mayor had succumbed to gaol fever. Finally, two years after the tragic assize, Pringle visited Newgate, and saw the windmill put into operation. It was rumoured that when the first blast of foul air escaped from the exhaust pipe, two men working on the roof fell down dead. This is quite credible, but as a matter of fact it is not true; but it is true that of the workmen engaged in installing the ventilating apparatus, seven out of eleven contracted gaol fever.

Pringle and the rest were convinced of the efficacy of their scheme and produced figures showing a great falling off in the incidence of the disease, just as figures can always be produced to prove anything. But it soon became evident that however much the convicts had benefited from the fresh air, the incidence of gaol fever had not abated. When the scheme had been in operation for several years, Akerman, the Governor of Newgate —the friend of Samuel Johnson, who figures at some length in Boswell's *Life*—reported that gaol fever prevailed all over Newgate, sixteen prisoners had died of it within one month, and he himself had lost eight or ten personal servants from the disease. Writing at this period, Lind stated definitely that ventilation would not check gaol fever. The opposition, as a counterblast, cited the case of H.M.S. "Sheerness" just returned to port from a long voyage, without having had a single case of typhus on board. The ship had been fitted with ventilating tubes, to which the commander and the authorities confidently attributed the immunity from ship fever. Lind disputed this *post hoc ergo propter hoc* contention, and the consequent

over-haul of H.M.S. "Sheerness" showed that the carpenters responsible for installing the ventilating tubes had neglected to turn on the stop-cocks controlling them, and so they had never come into operation at all. Finally, it was decided to rebuild Newgate, and the work was commenced twenty years after the Black Assizes. Hardly was the new building finished, when the Gordon Riots broke out and Newgate Prison went up in flames. This upheaval occurred in consequence of the repeal of the legal disabilities which had been imposed on the English Roman Catholics in the reign of William III. A number of honest and well-meaning persons, seeing themselves dragged off to Smithfield and incinerated there, banded themselves into a body named the Protestant Association, whose object was the repeal of the Toleration Act. As their leader they chose Lord George Gordon, a son of Cosmo, Duke of Gordon, a creation now extinct. He was an eccentric and ill-balanced young man who, in a roundabout fashion, had gained a seat in Parliament through his unbounded hospitality, and his fluency in the Gaelic tongue. He made such a nuisance of himself in Parliament, that, according to a current jest of the time, there were three parties in the House of Commons—the Government, the Opposition and Lord George Gordon. The Protestant Association arranged a monster demonstration in London, but the honest folk were overwhelmed by a mob made up of thousands of criminals, and the scum of London, much more interested in plunder than in popery. There ensued the most disgraceful orgy of lawlessness and crime that London has ever witnessed. For six days the rioters held the streets, plundering and burning as the fancy took them. They stormed Newgate, freed the prisoners and set the gaol on fire. Frenzied with success, they attacked Clerkenwell Prison, the King's Bench, the Fleet, the Borough Clink, and the New Bridewell, captured them all, released the convicts, and fired the gaols. The pusillanimity of the Government and magistrates passes belief, and finally the King himself set the troops in motion, and the Gordon Riots were quelled, but not until hundreds of rioters had been shot dead or bayoneted in the streets. Lord George Gordon was arrested, but secured an acquittal for want of evidence that he had been concerned in the disorder. He continued to give trouble to the authorities and, on the occasion of some friction between the Dutch and a Catholic power, he appeared again as Protestant champion. Decked out in a Dutch uniform, and carrying a Highland claymore, he paraded the streets, and persuaded the guard at St. James's Palace to mount Protestant cockades in their hats, and turn out and present arms to the Dutch Ambassador. Again, in furtherance of a crusade to abolish hanging and transportation, he tried to force his way into Newgate, where he counted, reasonably enough, that his views would be received with lively satisfaction. Finally he was committed to Newgate himself for criminal libels uttered in the course of further political adventures. He lived there happily enough, consoling himself, sometimes with music, sometimes with the bagpipes. I have mentioned Lord George

Gordon at some length, for in the end he was released from prison, and at the same time delivered out of the miseries of this sinful world, by contracting typhus fever, of which he died in Newgate Gaol.

Just as typhus was justified of its name of gaol fever, so it deserved equally its titles of ship fever, and camp fever. Writing in 1757, Lind says that this disease is the "most fatal and general cause of sickness in the royal navy" and that the mortality from it in the late war was "greater than by all diseases and means of death put together." From the time that typhus is identifiable from the symptomatic descriptions, we find it an invariable accompaniment of naval and military operations, provided that these were sufficiently prolonged; and, when epidemics of some other kind broke out, typhus usually was engrafted on the original infection. We see an example of this during the great epidemic of the bloody flux—bacillary dysentery—after the battle of Dettingen in 1743. The British sick were crowded into the village of Feckenheim where typhus broke out with an appalling mortality amongst the troops exhausted by dysentery. However mild or severe, says Pringle, the flux for which the patient was sent to hospital, the fever almost certainly supervened. Half of the sick died, with one or two exceptions all the medical staff were attacked and over a third of these died. Pringle says that the inhabitants of Feckenheim having received from the troops first the flux, and after that the fever, were almost utterly destroyed. Orders were received to remove the sick from Germany to Flanders, and, to the number of some three thousand, they were embarked on boats for transport to Ghent. During the voyage typhus rose to such a pitch of virulence that more than half of the troops perished on the way. On arrival at Ghent, there was a significant extension of the epidemic. Some old tents which had been used for bedding on the voyage were sent to a tradesman in Ghent for repair. He employed twenty-three hands on the work, these were infected with typhus, and seventeen of the twenty-three died.

Prior to the campaign against the Highland Jacobites in 1746, gaol fever and hospital fever were conjectured to be the same disease, as the symptoms were recognised as identical in every point, but proof was lacking until an outbreak in the Duke of Cumberland's army set the matter at rest. A French ship, bringing help to the Scottish Jacobites, was captured off the English coast; among the troops on board was a number of British deserters who in Flanders had gone over to the French. Highland lads, probably, who hearing the clan pipe, felt themselves constrained to dance. However, the deserters were thrown into prison in England until an opportunity should offer of sending them to Inverness for trial by court martial. Finally, to the number of thirty-six they were put on board a transport conveying Haughton's regiment to Nairn as a reinforcement after the Battle of Culloden. Some of the deserters were suffering from gaol fever contracted in the English prisons. Within a few days of disembarkation in Scotland, over 200 men of the regiment were seized with gaol fever; they infected

the hospitals, and the resulting epidemic spread to the inhabitants of Inverness—all the train of events so familiar in hundreds of outbreaks of hospital fever, but in this instance, to the enlightenment of the beholders, arising in the first place from gaol fever.

As regards the civil population, I have already referred to the dreadful famine-pestilences general throughout England in mediæval times, and similar, though less intense, epidemics of typhus occurred at intervals in this country until the end of the 18th Century, continuing in Ireland for a further fifty years. In the intervals between these epidemics, typhus was always present, as can be seen from the Bills of Mortality so long as the spotted fever deaths remained a separate entry. Further, it is noteworthy that any material increase in the spotted fever figures is always accompanied by a rise in the much larger mortality recorded as due to fever, indicating that typhus was an important constituent of the undifferentiated fever group. One may add that through all this period we find symptomatic descriptions of the disease which leave no doubt of its nature. Especially during the later epidemics, like that of 1741, there is unmistakable evidence of accompanying relapsing fever.

During the 17th and 18th Centuries we can trace a curious change in the class incidence of typhus fever. In Stuart times, although the epidemics commenced amongst the poor and hunger-stricken, the affluent and the great enjoyed no immunity from attack. We find many examples of this in the records of the times. The fascinating collection of letters, published by Birch, the antiquary, about 160 years ago under the title *The Court and Times of James I*, includes a series of letters from John Chamberlain, Esq., to Sir Dudley Carleton. Scattered through the letters we find the names of various notabilities affected by the great epidemic of typhus in 1623, mention of the panic the disease caused, and the prevailing dread lest it should turn to plague. Thus Chamberlain says that the spotted ague "reigns almost everywhere"; the Duke of Lennox is dead of the disease in Northumberland, and the Marquis of Hamilton in Rickmansworth; the Lady Hatton's family are ill in Essex, and her younger daughter dead, "a pretty gentlewoman, much lamented." So too, Lady North's second daughter has died in Tunbridge Wells. In consideration of the danger, the opening of Parliament is postponed from 4th September to 15th February, and when 15th February comes round we learn that Parliament has been again adjourned. For the same reason, the Lord Keeper comes but little to Westminster Hall this term, and Chamberlain complains that some law business of his "hangs in suspense and can get neither backward nor forward." The spotted fever, he says again, "is spread far and wide, and takes hold of whole households." "God keep it from among us, for we are in danger."

Thirty-odd years later, Samuel Pepys, in recording a dinner with the Countess of Sandwich, notes that she "is in handsome mourning for her brother, Mr. Samuel Crewe, who died yesterday of the spotted fever."

Towards the end of 1663 the Queen, one of the pathetic figures of English history, was seized with some severe malady. At the Earl of Sandwich's house Pepys is told that the Queen's sickness is the spotted fever, and that "she is as full of the spots as a leopard." With characteristic prudence he sends "to stop the making of my velvet cloak till I see whether she lives or dies." Again in 1685, and during the several years of scarcity at the end of the century, the "universal pestilential spotted fever" prevailed; so too, around the years 1710 and 1728, and again in 1741, when the total death rate in London reached such a figure that we have to go back to the plague year of 1665 to find a parallel mortality.

As the 18th Century advances, typhus becomes more and more limited to the poor and distressed, people in comfortable circumstances escaping in the main except for those whom duty or humanity brought into contact with the destitute, a condition of affairs existing in Ireland within the memory of many still alive.

During the early part of the 19th Century, the country was in a state of temporary prosperity owing to the Napoleonic War, and although typhus —that barometer of social well-being—persisted, there was no extensive prevalence of the disease. With the peace after Waterloo there came unemployment, and a fall in wages, and several bad seasons in succession damaged the crops. With the dearth came fever, severe in England, worse in Scotland and worst of all in Ireland, the poorest of the three. In England and Scotland the epidemic was mainly relapsing fever with a strong admixture of typhus, but in these countries, although distress was common enough, there was no widespread starvation as in Ireland where the preliminary relapsing fever was swamped in a torrent of typhus. Even in favourable years the poorer Irish were never far above hunger level, and now—with the potatoes rotten in the ground, the corn still green in the month of November, their cattle seized for arrears of rent and tithe— nothing stood between the peasants and stark famine. Soaked with rain the peat could not be dried, and their fires failed. They could not cleanse themselves, nor wash their clothing, and even those ordinarily cleanly enough became infested with vermin. In England there was a Poor Law, and a system of relief; in Ireland there was neither, and to escape certain death from hunger, hoards of starving families deserted their homes, and roamed over the country seeking for something to keep body and soul together. Dysentery broke out, then relapsing fever, and last typhus. A single focus of fever sufficed to infect whole parishes, for at night the migrants crowded into cottages along the roads, and over the hillsides, and multitudes of peasants fell victims to their kindly custom of never denying to any wayfarer the poor shelter they had to give. Tens of thousands died of hunger and fever, until the warm summer and good harvest of 1818 slowly brought both famine and fever to an end.

In the great famine which commenced in 1847, the mortality was still more ghastly. Even the census figures, which understate the total death

rate by about half, give: Dead of hunger, 18,000; dead of fever and dysentery, 290,000. The total mortality directly attributable to the famine in Ireland cannot have been less than half a million. Nothing comparable to this occurred in England, though the number of deaths recorded as due to typhus in the worst of the famine years was some 30,000. In this, as in many previous famines, a curious difference was noticed in the case-mortality of the peasants as compared with that of the more comfortable, or wealthy, classes; although the total mortality amongst the hunger-stricken was appalling, the recoveries far outnumbered the deaths; but of the clergy, doctors, almoners and others, who were attacked the great majority perished, a high case-mortality recalling that of the Black Assizes. It was noticed, too, that when such persons were exposed both to relapsing fever and typhus fever, they escaped relapsing fever and contracted typhus, though the disease did not spread to their families.

Typhus lingered on in England, with minor exacerbations corresponding with years of shortage, as during the cotton famine at the time of the American Civil War. In 1869, the recorded deaths from typhus in England were 4,000-odd; twenty years later, the figure had fallen to 160, followed by a further fall. But even today, typhus is not extinct in England, and in the returns of the last ten years there is only one year where the typhus fever column is blank.

On reading old accounts of typhus fever, we cannot but be struck by the profound knowledge of the disease shown. Indeed, clinical descriptions written a couple of centuries ago are superior, in certain respects, to those we sometimes encounter in modern text-books of medicine: the early resemblance to a commencing cold in the head, the quickened pulse while the patient still seems to have little wrong, the suffused eyes, the tremulous hands, the parrot-tongue and so on, are all emphasised. The characters of the rash are stated very clearly, the usual non-involvement of the face; these old writers knew that the rash might appear on the fourth day, or not until the fourteenth, or might not be seen until after death; they knew that many cases of typhus have no rash at all. It was pointed out recently that in cases of typhus without an eruption, a ligature tied round the arm may dilate the damaged vessels sufficiently to produce petechiæ distal to the ligature. I think that someone's name even has been attached to this phenomenon, but this effect of a ligature was known centuries ago, and Pringle records such an instance in his *Observations*. Boghurst, writing on the London plague of 1665, gives carefully the differentiating characters of the typhus eruption, and the tokens of plague. In the first place, he says that in spotted fever the ordinary plague signs, bubos, etc., are absent. Then, the spots in spotted fever are smaller than tokens, and more numerous. They are never any colour, he says, except purple, or red-brown; whereas tokens may be black, purple, bright scarlet, sometimes even violet or sky blue, but usually not these last except after death. In spotted fever, the rash comes out first about the neck, very thick, and afterwards all over

the arms and breast like flea bites—by the way, the neck as the earliest site of the rash is emphasised independently by many of these old authors. He stresses the higher temperature in spotted fever, as compared with tokened plague, for, he says, the more the fever in plague the less apt is the patient to have tokens. And finally, the fatal significance of the plague tokens, as he calls them the "forehorses of Death's chariot."

These men recognised, further, an atypical variety of typhus fever, like Brill's disease, very difficult to diagnose by reason of its mildness; and observed that when such cases were crowded into hospitals, gaols, etc., by concentration of contagion, as they express it, the infection assumed the malignant petechial character, and grew very mortal. The complications, too, are clearly set out—the deafness; the eye lesions, including the late cataracts; inflammation and suppuration of the parotid and sub-maxillary glands; orchitis; adenitis; late œdema; gangrene of the skin; gangrene of the extremities; gangrene of the intestine; even the rarely-occurring patches of softening in the brain, with paralyses; and the rare orbital abscesses. Indeed I do not think that there is a single complication mentioned in Daniélopolu's monograph on typhus which is not recorded by these old writers.

Their observations on the dissemination of the disease were amazingly accurate; they knew it was spread by actual contact with the sick, and by clothing, bedding, and so forth contaminated by them; and that naked persons transmitted the infection less readily than those who were clothed. Army physicians of the Dettingen and Fontenoy period were warned not to come into actual contact with their hospital fever cases, but to stand at a little distance, and in examining the pulse, to step forward, pick up the patient's wrist, and as soon as possible step back again. They knew that typhus patients thoroughly cleansed and given fresh straw could be nursed amongst others without danger of contagion, and that if such measures could be instituted and maintained, hospital fever would not break out. On one occasion during the Seven Years War, Donald Monro found himself unable to isolate the typhus cases of the Coldstream Guards, so taking care to keep them scrupulously clean, and to space them out—or, as he calls it, lay them thin—he nursed them in his general wards without any spread of the disease. So on retiring from the army, he says, he introduced this procedure into St. George's Hospital with complete success. Even the possible rôle of lice as vectors of typhus was considered, and Lind, in advocating sulphur as an efficient fumigant for typhus-infected clothing, points out that sulphur does not destroy lice, "From which we might be led to imagine that contagion is not propagated by Animalcules." In Lind's experience, presumably, the sulphur destroyed the active forms of the lice, and put an end to the disease; the more resistant eggs hatched out later, and so the clothing although disinfected was not loused.

Lind's recommendations to eradicate gaol fever could hardly be bettered to-day. He advised that all prisoners should be stripped, thoroughly

cleansed, and their clothes either fumigated in a special smoke-room or baked in an oven; no infection, he says, can resist the heat of an oven. He points out that these measures will not only check gaol fever, but will also louse the prisoners. When brought into court, the prisoners should wear special washing clothes, which after use must be washed in soap and water, and steeped in hot vinegar. To put an end to ship fever, he advocated the provision of depot ships, where all men drafted to the Navy would be detained, thoroughly cleansed, and given fresh outfits. If Lind's counsel had been heeded, the Navy would have escaped the appalling epidemics of ship fever during the succeeding American and French Wars, when the fleets would come into port, and land so many thousands of cases of ship fever, that we wonder that sailors enough were left to man the fleet. Some individual officers, like Captain Arbuthnot of the "Terrible," cleansed their crews, as advised by Lind, and freed their ships of typhus, at any rate for a time; but, so far as any official action resulted, Lind was but a voice crying in the wilderness, and ship fever persisted in the Navy for another half-century, in conditions summarized by Smollet, himself a naval surgeon, in *Roderick Random* where he says that it was surprising, not that the sick should die, but that any of them should recover.

My time is drawing short, and in this somewhat cursory address I fear I have never passed the bounds of common knowledge. Like Mark Antony, I seem to have only "talked right on, and told you that which you yourselves do know." Instead of scraping superficially here and there over so large an area of ground, one might with advantage have restricted the field, and delved more deeply. One might have enlarged on many points—on the habits of lice, for example, most interesting creatures, though usually not esteemed a fit subject of drawing-room conversation. There we might discuss lions, or burning fiery serpents; even house flies, creatures of filthy and repulsive habits, might be mentioned without offence; but any reference to the clean-feeding, clean-living louse would be accounted utterly scandalous. Why? Well I'll tell you. If, in some family of your acquaintance, you found that the subject of capital punishment was studiously avoided and if, when introduced by an outsider, there was an uneasy silence, and an awkward change of the conversation, on enquiry probably you would find that some member of the family, perhaps the grandfather, had been hanged by the neck until he was dead, and his relatives have not got over the disgrace. And that is the reason why the mere mention of lice makes people uncomfortable and self-conscious, for it is so short a time since they themselves were liable to infestation that they are still a little bit touchy. Why, I know people who would not quote Burns's lines about seeing ourselves as others see us, if they realised that they were addressed *To a Louse, on seeing one on a Lady's Bonnet, in Church.* We did not always suffer under this extreme degree of refinement. Why did the Tudor ladies carry long-handled little curry-combs to scratch their backs? Why did the Stuart gentlemen shave their heads,

and wear wigs—not always with success, for Samuel Pepys examined his new periwig, and found it full of nits? The good Anglo-Saxon word, louse, was freely bandied about as a convenient term of reproach, and even high-born ladies were twitted with their tendency to ecto-parasitical invasion. When the third Countess of Holland quarrelled with Theodore Hook, she turned him out of doors, and said she didn't consider him worth "three skips of a louse!" Theodore Hook retaliated with four lines of verse, quoted so often as to be worn a little threadbare, but which even now might be repeated:—

> "Her ladyship said when I went to her house,
> That she did not esteem me three skips of a louse;
> I freely forgave what the dear creature said,
> For ladies will talk of what runs in their head."

Typhus fever has a peculiar and personal interest for us here to-night, for beyond all other diseases it has taken heavy toll of our profession. Away back from the time of the Pestilence of Athens when Thucydides wrote "the physicians were among the first victims," down to the German prison-camps of our own day, we cannot read the story of any great outbreak of typhus, and not see under the altar the souls of them that were slain—physicians, surgeons, hospital-mates, they perished singly, in tens, in twenties, sometimes, as at Brest, in hundreds. In Ireland alone, of 1,200 doctors attached to institutions for the sick, 550 died of typhus fever within twenty-five years. And so the reckoning mounts up, a great multitude which no man could number. And there is still another category. The Polish Commission dedicated their report to the memory of research workers who died of typhus fever contracted during their researches. Hardly was the ink on the report dry, when one of the dedicants, A. W. BACOT, a Fellow of this Society, in like manner had paid the vile tribute of untimely death. And since then, another of our members, Major CRAGG. Tragic, lamentable, but most noble deaths: "*Homines enim ad Deos nulla re propius accedunt quam salutem dando*"—For in no wise can mankind more nearly resemble the Deity than in bestowing health.

NOTES ON THE MEDICAL SERVICES IN THE FIELD.

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Royal Army Medical Corps.

(Continued from p. 357.)

PART III.

Sanitary Sections.[1]

There still remain for consideration certain medical units whose activities take them into the Army areas. The first of these is the Sanitary Section. This is normally a divisional unit, one being mobilized with and moving with each division, but similar units are also mobilized as required for work on the L. of C. It is very necessary that one of these should be amongst the very first troops to be dispatched to the base of the area of concentration, and that the actual divisional sanitary section should be very early on the spot in the area of concentration.

Now the infantry divisional sanitary section is normally for administration purposes, under the A.D.M.S. of the division to which it is attached, and in mobile warfare accompanies the division when it moves; but when divisional areas become stationary, and troops move from one such area to another, or are relieved in the one area, then the control of the movements of sanitary sections passes back to the Army, and the units become Army area units, and not divisional units, though for actual working they may be still at the disposal of the A.D.M.S.'s of the particular divisions occupying the areas in which they are located. The number of sanitary sections required will in this case correspond to the number of sanitary areas or sub-areas mapped out and charted by the Army, and not necessarily to the number of the divisions mobilized. They may increase or decrease in numbers according to the numbers of new areas or sub-areas taken over or given up. Army sanitary areas are under the control of the Deputy-Assistant Director of Hygiene, Army.

On the L. of C. the number of units employed depends entirely on the length of the lines and importance and size of the various bases and posts. For example, a large base will require one sanitary section, railhead or advanced base, half a section, and each post in between a sanitary squad; this last-named consists of one R.A.M.C. N.C.O. sanitary inspector with up to five R.A.M.C. trained sanitary men, and locally employed labour as required. They are all commanded by the O.C. sanitary section working under the control of the D.D.M.S. (or A.D.M.S.), L. of C. through his A.D.H., or D.A.D.H.

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[1] Since this article was written the official designation of the Sanitary Section in the British Army has been changed to "Field Hygiene Section."

A cavalry division sanitary section accompanies its division from one area to another, moving with it wherever it goes. This is chiefly on account of the importance of the proper disposal of manure.

The personnel of a sanitary section consists of 1 sanitary officer (not necessarily a medical officer), and 27 N.C.O.'s rank and file R.A.M.C., and 4 attached R.A.S.C.M.T. The R.A.M.C. men are all trained in special duties, e.g., 8 N.C.O.'s as sanitary inspectors, 1 N.C.O. and 5 men skilled in wood, iron, painting and mechanical work and 5 men as sanitary orderlies. In the cavalry unit there is an additional N.C.O. and 3 men. The vehicles consist of 1 light and 1 heavy motor van, 1 motor lorry disinfector and 9 bicycles (12 in the cavalry unit). The equipment is chiefly workshop tools, a few brooms, axes and spades, a wheelbarrow, spare parts for the bicycles, bleaching powder and the necessary articles for the internal economy of the unit. A study of the personnel and the equipment shows the unit to be one intended to carry out skilled supervision, and to direct the work of others rather than itself to carry out actual necessary sanitary duties, and to be lacking in the labour element. This is to be supplied by regimental and departmental units in their own areas, and by locally engaged civilian personnel or labour corps in non-unit areas. The bicycles indicate the amount of inspectorial work that must be carried out.

Generally speaking, then, the duties of a sanitary section are to act as skilled instructors in hygienic methods and as supervisors of conservancy work, especially outside unit lines and in connexion with the smaller units who are less able to look after themselves. They form a sort of protective health screen between the troops and the civil population, as they work in with the civil health authorities through the A.P.M., town commandants, etc., and they are empowered with the authority of Sanitary Police. When required, they exercise the necessary skilled supervision over units in regard to the construction of sanitary appliances in their lines. But in their dealings with units provided with M.O.'s it is always necessary to remember that the medical officer is the adviser of the O.C. unit, and their representations should be made through him. A most important aspect of their duties is in connexion with infectious disease and its notification, the marking of infected billets and disinfection of the same either by their own appliances or through the civil authority, and the disinfection of clothing. Adjuvant to this is the supervision of ablution places, bathing establishments and laundries, especial attention being paid to waste water disposal, and to the disinfestation of vermin-infested clothing. The supervision of central water supplies and their proper protection and purification come, too, within the scope of their duties. When troops move it is very necessary for the sanitary sections to see that the proper cleaning up of the vacated areas, the proper closing of latrines, and the destruction or sanitary disposal of rubbish, manure, etc., are effectively carried out. This is especially of importance in the case of units with numbers of animals attached.

In India the Sanitary Section, as laid down in War Establishments, India, is a mixed unit, having 12 trained sanitary R.A.M.C. N.C.O.'s and men, 9 trained Indian N.C.O.'s and men, and 70 Indian followers. Of these last-named 9 are trained as skilled workmen or mistris, 36 are sweepers for conservancy work, and 21 are coolies chiefly for constructional labour and for manure burning work. It will be seen, therefore, from its composition that much actual executive sanitary work falls to the lot of the sanitary section in India, especially in connexion with transport units, and very small units and detachments which in some cases appear without sweepers or sanitary appliances of any description, and are expected to be dependent on some adjacent unit for these necessities of life.

The method in which the Indian Sanitary Section forming part of a moving force is employed is as follows: When the force moves out, each unit leaves a portion of its unit sanitary detachment behind to clean up the ground occupied by it, close the latrines, and see that every waste thing combustible is left burning. The sanitary section is divided into two parts, one accompanying the troops, and the other, half or two-thirds of the unit, remaining behind to assist in the cleaning up especially of the transport lines, the outskirts of the camp, and the areas of the small detachments which have possibly only one sweeper each who has to accompany his unit. This rear sanitary party works on until the camp is cleaned, the O.C. section remaining behind to supervise; it is most important that the work should be done rapidly and thoroughly as the site will probably be occupied later the same day by L. of C. troops coming up to protect the line. When the work is finished, the rear sanitary party either rejoins the main body the same day or, more commonly, remains behind till the following day, when it rejoins with the up-going convoy, the other half of the section now carrying out the work done by the first half the previous day. In these Indian mobile forces, supplied as they are with pack transport and with animals running into thousands, the disposal of manure is a very difficult problem. The manure is practically pure dung, and will not burn until it has dried. The forage is usually all eaten up, and there is very little waste to assist in the burning. The bale iron round the forage is all saved and made into incinerator grids, and each unit is instructed to make one such fresh grid to take along with it each time it moves so that it can have an incinerator going as soon as it arrives in camp for the burning of solid excreta and rubbish. Thus, when it moves off, it can leave behind its rubbish, burning properly, without having to dismantle its incinerators in order to take along its iron fire-bars.

Especial attention must be paid by the sanitary section to the slaughter area; animals for slaughter are all brought up on the hoof, and the killing is done on the spot. As there is no time to dry and save the skins, these must all be burned with the entrails. Burial has sometimes to be resorted to, but is very unsatisfactory on account of fly breeding. In one test made

in Waziristan in 1920, entrails were buried and covered with two feet of earth in a fresh camp where flies were practically absent. On returning two months later after considerable snow followed by winter weather and the occupation of the camp as an L. of C. post, the flies had become very numerous, there being also other sources of origin than the buried entrails. One of the entrail pits was opened up to see the condition of affairs, and as the loose earth was shovelled away flies with closed crinkled wings were seen crawling amongst it, and when thus liberated of the weight of earth their wings expanded and they flew off. The nearer to the buried entrails the spade arrived, the more numerous the flies became.

Medical Stores Depots.

These depots are of two kinds : (*a*) Advanced, which are army units, and (*b*) base, L. of C. units. Advanced depots draw their stores from base depots and any local sources, and supply field ambulances, casualty clearing stations, motor ambulance convoys, sanitary sections, advanced convalescent depots, and in certain cases unit requirements. As a rule, regimental M.O.'s obtain their medical stores through field ambulances, but on occasions may have to indent direct on the advanced depots. In any case the field ambulance motor vehicles are the means by which medical stores are sent up to the front line. These depots are mobilized to the number of three per army of three corps, i.e., one per corps, and they are controlled by the D.M.S. Army. They are usually situated close to a C.C.S. group, and require suitable buildings near a railway line to allow for protection from weather and to facilitate the obtaining of additional supplies. Their staff consists of one quartermaster in charge with one N.C.O. dispenser, one clerk, and four packers and storeman, of whom one is a carpenter. The transport consists of one Ford box van with R.A.S.C. driver for distribution of stores. It will be seen, therefore, that for their moves they require assistance from "Q" Branch of A.H.Q.

Base stores are mobilized normally to the number of one per army; but where one army has two bases and two different L. of C., an additional base store is required, or one is divided into two with some slight additions. They are controlled by the D.D.M.S., L. of C., and supply the wants of L. of C. medical units as well as advanced depots. Where there is more than one store, there is formed a stores branch on the staff of the D.D.M.S., and all indents for supplies pass through this to the War Office or to the medical stores in the home country. It was found in the Great War that if base stores indented individually direct on the home store, accumulations of stores occurred overseas through one store not drawing on the surplus stock of another. By thus controlling them much unnecessary accumulation and deterioration of stores was prevented, and likewise the supply of numerous varieties of certain articles indented for to meet the idiosyncrasies of individual officers was modified to correspond with articles recommended by a selection committee. The staff is considerably larger than that of an

advanced depot, consisting of two quartermasters, one W.O., and nineteen other ranks. Sera and vaccines require especial care, and they are placed in charge of additional special staff (which, if the demand is likely to be great, consists of two N.C.O.'s and two privates) for their care and handling. Like other base units stores have no transport, being dependent for it on "Q" Branch of the L. of C. H.Q. Staff. Additional labour is also required for unloading from ships and loading for dispatch.

Mobile Laboratories.

These are army units. The official ones are: One hygiene laboratory per army with its headquarters normally at railhead or the advanced base, and two pathological laboratories per army, one or both of which work in the C.C.S. group areas, and sometimes one in the advanced base area. Their field of work is much enlarged by the possession of a light motor car which enables an officer to advance right amongst the fighting troops if necessary, and certainly to the field ambulances, to assist in the elucidation of the diagnosis of infective diseases. The laboratory is a specially fitted-out hygiene or pathological unit on a motor lorry chassis, and is sometimes fitted with trailer attachment. The staff consists of two officers, one laboratory assistant, one batman, and three M.T. drivers. When the situation allows, a suitable room in a building is taken over for working in.

Other mobile laboratories or medical branch outfits in use during the Great War were X-ray outfits and dental outfits; though now that C.C.S.'s are furnished with X-ray outfits (a perfectly satisfactory field outfit has yet to be devised), and that dental officers with field outfits are attached to field ambulances as well as to C.C.S.'s, the necessity for the travelling outfits is not so great. It may be mentioned that the Americans utilized travelling operating theatre outfits with surgical teams accompanying them.

All these special mobile units are directly under Army control, though they may be placed temporarily at the disposal of corps. Fuller details of the working will be found in the various volumes of the Medical History of the War. They are of more particular interest to the specialists in these subjects, and it is not necessary to enter into particulars here.

Ambulance Trains.

These are L. of C. units under the medical control of the D.D.M.S. (or A.D.M.S.) L. of C. Their actual movements are carried out by the transportation section of "Q" Branch, on demand by the D.M.S. Army. They are of three kinds, viz. (*a*) ambulance trains proper, (*b*) improvised ambulance trains and (*c*) temporary ambulance trains The last-named (T.A.T.) are made up at short notice to meet the requirements of special emergencies when the normal service is insufficient. They consist of ordinary third-class rolling stock, with one first or second-class coach for personnel and officers, and are intended to take sitting casualties and very lightly wounded who need little or no attention on the journey and can look after

themselves. It is useful to have an "upper berth" for bad sitting cases who may develop into lying cases during the journey. If the class of case is properly selected these trains serve a very useful purpose, as they can deal with large numbers—one train in some cases being capable of taking up to 1,000 sitting cases. There can of course be no hot meals supplied on the journey, except at halts, which are necessary periodically for purposes of nature, for supply of drinking water, hot drinks, &c., and for medical attendance on a certain number who may require it. These halts are arranged for at certain specified stations, where necessary preparations have been made; otherwise boxes of rations which need no cooking, are made up of bread, cheese, biscuits and jam, each box containing the requirements of one compartment, and one is issued to each at the entraining station. The personnel are detailed temporarily from the regular ambulance train service, and consist of 1 M.O., 1 N.C.O. and 8 O.R.'s, all instructed in train work. Special orders for the control of such trains are laid down and issued to the M.O.'s. On the cessation of the emergency the train is immediately broken up and the personnel returned to their units. Difficulties in control of the casualty patients are frequent at the halts, as the men get out and wander away, and it is very necessary to put each carriage and coach under the charge of the senior N.C.O. casualty therein, and under the control of one R.A.M.C. orderly for each section of three coaches. Each train carries a definite scale of supplies, medical comforts, medical, surgical and ordnance equipment to meet requirements. Necessary particulars of the dispatch of such loaded trains are wired to the D.M.S. L. of C and A.D.M.S. detraining base, giving the source, numbers and destination of the casualties as determined by the A.D.M.S. ambulance train.

Improvised ambulance trains are taken into use when a force moves overseas and ambulance trains proper are not available in the country, or have not yet arrived from the home base. They are made up of (1) the best type of covered goods rolling stock available in the country, or (2) of passenger parcel vans, or (3) of ordinary third-class passenger coaches, partly gutted and converted, or (4) of corridor communicating coaches for lying casualties, and ordinary passenger coaches and brake vans for a proportion of sitting cases, personnel, stores and cooking. The lying accommodation is provided by fitting sets of Brechot-Desprez-Ameline frames for stretchers. Each frame consists of three tiers, and each goods wagon will take four sets, i.e., twelve lying patients. The sets are kept ready in Ordnance for mobilization, and transhipped with the force. These non-communicating trains are never satisfactory, and the goods wagons, having only two ordinary axles, are uncomfortable, have no heating or lighting arrangements, no automatic brakes and no sanitary or water fittings. The passenger vans are generally fitted with bogey wheels, heating and automatic brakes. The corridor stock, whilst being convenient from the communication point of view, has ordinarily no lying accommodation, except when the long-distance "wagon lits" are available; and they

require considerable alteration. It will thus be seen that the composition of these trains depends to a very large extent on the nature of the rolling stock available, although in their assembly a definite scale is followed as far as possible to enable their composition to be based on the lines of an ambulance train proper. A further point to be considered is that the rolling stock of different companies varies, and each train should therefore be made up of the stock of one company. This is particularly important from the point of view of repairs, as one company does not keep the spare parts of another, and a composite train may thus be put out of action for a long period when undergoing the necessary three-monthly overhaul for the lack of necessary replacements. The number of goods vehicles required to make up a complete train is about forty.

The ambulance train proper is really a mobile hospital and is complete in itself. It is specially built, constructed or fitted for the purpose, and provides accommodation for 396 lying patients in addition to personnel. In its evolution, it has undergone numerous alterations and rearrangements from time to time, and it is liable to changes to meet the special local conditions of the country and campaign for which it may be used. It is about 320 yards in length and ordinarily consists of an engine and sixteen communicating bogey coaches arranged somewhat as follows, though different trains have variations according to the period of construction :—

Engine ; Coach No. 1, brake and infectious ; No. 2, M.O.'s and sisters ; No. 3, kitchen and sitting officer patients ; No. 4 to 7, wards ; No 8, office, dispensary and dressing theatre ; No. 9 to 13, wards ; No. 14, kitchen and cooks ; No. 15, personnel ; No. 16, stores and brake van. Each ward coach accommodates thirty-six lying patients, or a larger number of sitting cases. The staff consists of 3 M.O.'s (one major as O.C.), 3 sisters, 3 W.O.'s and N.C.O.'s, and 42 rank and file. One train is mobilized per division, and two per corps of three divisions.

In France, owing to the vast size of the force, the control of the supply and running of ambulance trains was somewhat complicated, as the number and extent of the army areas, the necessity of arranging the runnings to fit in with those of the numerous supply trains and the limitations of the railway system had to be taken into consideration. With a smaller force, the channels would be considerably fewer and shorter, though the underlying principles would be the same. The actual system latterly adopted was somewhat as follows: From reports received from the O.'sC., C.C.S.'s, the D.M.S. Army noted the requirements of each C.C.S. and made his demands accordingly on the A.D. Transportation (of "Q" Branch) of his army, who in turn demanded the trains from, the Director of Transportation, G.H.Q. The latter instructed his L. of C. representative on the Railway Branch to arrange for the supply of the trains if available. This officer, the A.D.R.T., instructed the R.T.O. of the ambulance train garage, where the trains were kept in waiting, to dispatch the trains to the C.C.S. railhead in charge of the O.'s C. ambulance trains, as

required by the D.M.S. at railhead. The movements of the train were controlled by the R.T.O. railhead.

The O.C. train, having loaded up his train, notified by wire the A.D.M.S. ambulance trains (who with a D.A.D.M.S. was on the staff of the D.D.M.S. L. of C.) of the completion of the loading, and of the number and varieties of the casualties. The A.D.M.S. was kept informed daily of the numbers of vacant beds at the various L. of C. hospitals and on this decided the destinations of the varicus trains, either before or on receipt of the loading notification of the O.C. train. Notification of these proposed destinations was passed immediately to the D.T., who sent out instructions through the Railway Transportation Officer concerned to the R.T.O. at the ambulance train garage, and hence to the O.C. ambulance train. If the A.D.M.S. had not yet notified the transportation branch of the required destination of the train, it was despatched by the R.T.O. railhead on its way towards the base, and on receipt of the information this was wired down the line by him, to catch the train in time to turn it into the right channel at the appropriate junction, the D.D.M.S. (base) or O.C. hospital, and R.T.O. at the detraining station being also notified so that they might be prepared for its arrival.

At the detraining station, on completion of the unloading, the O.C. train informed the D.D.M.S. or A.D.M.S. base, through his D.A.D.M.S., of its completion; the latter passed on the information to A.D.M.S. ambulance train.

The R.T.O. detraining station then despatched the train to its garage in its army area, via the A.T. supply store, for replenishment purpcses, and notified the D.T., who was thus kept informed of what ambulance trains he had available to send out from his pool. In the meantime the train was receiving the necessary cleaning and disinfection before being again sent out. In order to be nearer the C.C.S. railhead, a train might be passed from its garage to a regulating station, usually at an important junction, where it was held in readiness to proceed at once to the one of a number of C.C.S. railheads to be reached from this spot where it was most urgently required.

In continuous battles, lasting over many days, a regular daily service of ambulance trains was fixed, and a train was timed to leave C.C.S. railhead at a definite hour each day, and thereby O.'s C. C.C.S. were able to make their arrangements accordingly. When more than one C.C.S. was clearing casualties in one train, a local representative at railhead of the D.D.M.S. L. of C. co-ordinated the numbers to be sent from each, in order to prevent crowding, and waiting at entraining stations. To alleviate this event, which occasionally occurred in spite of arrangements, the D.D.M.S. L. of C., in conjunction with the movement and control staff, arranged for waiting and refreshment rooms suitably fitted.

Ambulance trains are equipped with ordnance and medical equipment on special scales. The former comprises all that is necessary to complete

the fitting of the train to act as a light field hospital, and includes stretchers, blankets (3 per patient), pillows, sheets, towels, plates, mugs, spoons, kitchen utensils, brooms, etc.; and the latter, besides the usual set of field medical equipment, consists of additional drugs and dressings, including oxygen apparatus, which are likely to be required.

Besides the ambulance trains on the L. of C., a modified form of rail transport in front of the C.C.S. was used wherever possible in France and other theatres for the evacuation of casualties. In its simplest form it consisted of tramways or trolley-ways laid for the conveyance of water supplies and ammunition to the front line trenches on the up journey, and on the return journey of casualties from the tramway head, which became a collecting post, to the advanced dressing station of the field ambulance. The lines were laid in the communicating trenches themselves either on the floor or overhead, depending on which system was adopted, and also in the open. The trolley carriages were simple platforms, each on two pairs of wheels, and stretchers were placed on them, some were constructed with end-railings which allowed of stretchers being also placed across them in an upper tier, the total load being three below and two above. They were hand pushed by the field ambulance stretcher bearers, or in some cases mule drawn. Advantage was taken of local facilities for their construction when these existed, existing light railway lines and colliery trolley lines and stock being taken up and relaid as required.

The light railways themselves were taken into use whenever conveniently situated for conveying casualties from the A.D.S. to the M.D.S., and also to the C.C.S., and they were especially useful when it was possible to place a W.W.C.P. on one of them and so to connect it up to a C.C.S.; large numbers of sitting cases were thus easily conveyed in trucks. In some cases when the journey was long, a regular small ambulance train consisting of an engine and six trucks covered with tarpaulins or even fitted with racks for stretchers, was employed, the capacity of such a train being about 100 sitting cases or thirty-six lying cases. For these trains a staff of one R.A.M.C. N.C.O. and two men was appointed.

Decauville railways were used in many theatres of war for the dual purposes of conveying supplies and ammunition upwards, and casualties downwards. Both these returning empty supply trains and special ambulance trains were used. The latter usually consisted of two covered hospital trucks or specially constructed coaches on bogeys, each capable of carrying twelve lying cases, and of one large truck which accommodated twenty-four sitting cases. In Mesopotamia and Persia, special single motor hospital trolleys were also brought into use on the light railways constructed there.

Inland Waterways Ambulance Transport.

Mention may here be made of the method of evacuating casualties towards the base by means of barges and other river craft, use being made of canals and rivers to help the road and rail lines of evacuation. In France

the craft used were chiefly ordinary commercial river barges specially altered and fitted to meet the requirements of a hospital ward. The later ones were each provided with beds for 31 patients, and accommodation for 1 M.O., 2 sisters, 8 R.A.M.C. N.C.O.'s and men, and 3 I.W.T. crew, in addition to the necessary administration annexes, comprising kitchen, dispensary, store-room and laboratories. They were furnished with lifts, electric lights and fans, and warming arrangements, and the wards enabled the casualties to be conveyed in comfort almost equal to that of a hospital ashore. The barges were grouped in flotillas of six barges, one tug per barge being provided. The difficulty of manipulating more than one barge per tug on the narrow canals was too great to allow of a desirable economy both in tugs and personnel, though later on one tug and one M.O. were detailed for two barges. On larger rivers economy in tugs is possible. At night the vessels were moored to the banks, as they only travelled in daylight. This type of transport was chiefly used for special types of cases, seriously wounded, such as injuries to head and chest, and fractured thighs, for whom smooth transport was highly desirable, and it served a useful purpose. Over 70,000 casualties were conveyed by this means in France.

In other theatres of war, small native river craft were adopted for use for varying distances, and included types such as the native boat on Lake Dorian in Serbia rowed by one man and carrying one stretcher and one attendant, the small "bellum" of the Shatt-al-arab, a craft 15 to 20 feet long propelled by poling or paddling, and the larger one of the same name and the "mahela" of the Tigris, Euphrates, and Persian Gulf, with dimensions of 60 feet by 12 feet, capable of being propelled by sails if the occasion demanded it, but often towed by a tug. These mahelas were fitted with chetai (matting) roofing to give protection from the sun, the hold being generally open. In some of the larger ones, side-racks in tiers were fitted as cots or stretcher rests, a lifting hoist was provided, and a partial flooring was laid over the hold at deck level to increase the carrying capacity, but this made the holds very stuffy. When longer journeys had to be undertaken a latrine was fitted near the stern overhanging the side, and on these occasions the boats travelled in convoy, having a M.O. in charge on a separate craft containing stores and additional personnel. Specially constructed or converted hospital steamers of various types were used extensively later on the waterways of Mesopotamia and of North Russia for sick transport.

L. of C. and Base Hospitals.

The mobilization of a force for active service not only includes the actual medical units for front line work, viz., field ambulances and casualty clearing stations, but also a definite scale of L. of C. and base hospitals according to the strength of the force. A short account of how these establishments were affected by the situations on the Western Front

during the Great War will show the underlying motives which influence present-day arrangements.

When the Expeditionary Force was dispatched to France in 1914, these hospitals consisted of two stationary hospitals of 200 beds each, and two general hospitals of 520 beds each per division of the Army, including cavalry and the L. of C. troops. This gave a total of 1,440 beds per division, or a little over seven per cent of the strength of the whole force. The accommodation in the field ambulances, casualty clearing stations and convalescent depots was not taken into consideration when calculating permanent beds. As the force increased, and with it the need for increased accommodation, and as home hospitals came into use, modifications were found necessary. Both types of hospitals were found to be too small and were doubled, and in some cases more than doubled in size. The stationary hospital, originally intended for any place where a small hospital was required, possibly in the forward areas of the L. and C., or for a special type of case such as infectious disease, became to all intents and purposes a general hospital, though it retained its designation until after the war, and it has now been abolished. It was also found much more economical and easier of administration to increase the size of existing hospitals than to add to their numbers. Hence the vast increase which some of the general hospitals underwent when hospital centres were established; in one centre alone three of the hospitals had each 2,500 beds. It was at one time considered that beds for a force of not more than 500,000 men need be maintained in France, i.e., 35,000 beds at the rate of seven per cent of this number of troops, on the assumption that there would be adequate accommodation provided in Great Britain and sufficient means of transfer there. But the increase in the number of casualties, the difficulties of conveying such large numbers at once, the effects of submarine warfare, and the necessity for keeping the slighter cases in the country in order to provide early reinforcements, caused a considerable number of beds to be added to those available on the Western Front, so that at the time of the Armistice there were 95,000 beds in the various classes of hospitals there. The mean ration strength at the time was something over 2,500,000. This gave an accommodation rate overseas of 3·8 per cent.

At home the number of beds available at this time for patients from all sources, i.e., from troops in training at home and from all theatres of war, was 364,000. Many of these were filled up by the casualties of the preceding years of war who had not yet sufficiently recovered to leave. So it is difficult to estimate the number that can be attributed as available for the requirements of France. The total number of casualties received from the Western Front in home hospitals in 1918 was approximately 675,000, and only a further 45,000 were received from other overseas theatres, so that, excluding the home admissions, it may be assumed that at least 250,000 of these beds were occupied by or available for casualties from the Western

Front. If these assumptions are admissible it would appear that at least 250,000 + 90,000 = approximately 350,000 beds, were considered necessary for a force of 2,500,000, i.e., fourteen per cent. There are many fallacies in the argument, but they tend rather to under- than overestimate the eventual total requirements of hospital beds for a long continued modern war, which may therefore be regarded as in the neighbourhood of fifteen per cent of the Expeditionary Force strength if the figures for the operations on the Western Front can be taken as a criterion.

It was the aim before a big engagement to have at least 40,000 vacant beds in France alone. That these were very necessary was shown by the figures of casualties during 1916 in the Somme battles, when an average of 70,000 sick and wounded were evacuated monthly to England for five months, though in the first month alone 114,000 were sent back, whilst the largest number embarked on any single day was just under 12,000. The number actually admitted to field ambulances during this month was over 145,000, and in one particular period of twenty-four hours they received 26,600 wounded. It was only, therefore, by immediate evacuation to hospitals that such numbers could be dealt with, as at the beginning of the operations on July 1, 1916, there was a total of 61,000 beds of which 36,000 were vacant. The near ration strength of the whole force was in the vicinity of 1,300,000. The methods adopted to obtain in France the beds desired were: (1) Evacuation to England, (2) increasing the accommodation of convalescent depots, and (3) expansion of existing hospitals. This last-named was of two kinds : (*a*) "Normal expansion," by which the accommodation was increased nearly twenty per cent above the normal by taking over more buildings or increasing the number of tents or huts to the extent capable of administration by existing units; this expansion was of a semi-permanent nature; and (*b*) "crisis expansion," brought about (1) by reducing the bed space in existing hospitals and placing more beds in them, this giving an increase in beds of about thirty-three per cent over the normal, and (2) by utilizing dining, recreation, and other accessory rooms, as well as the rooms or tents of the personnel, and fitting them up with trestle cots and mattresses, an increase of about twenty-three per cent above normal being thereby obtained. To meet the requirements of this crisis expansion special sets of equipment were set aside and kept available by Ordnance for issue when the expansion was ordered, and an increase in the personnel of one M.O. and five other ranks was sanctioned for each additional 100 beds above the normal.

The development of special hospitals to deal with one particular class of case tended to increase, but this cramped and limited the general accommodation in addition to creating difficulties in regard to transportation by ambulance train ; whenever possible evacuation to England was preferred so as to prevent beds being occupied for long periods, and to leave them vacant for the really serious cases, which it was undesirable to move further. One particular class of case, viz., fractured thighs, was found to be benefited

by being retained for from four to six weeks, and at each base a selected hospital received all of these cases, who were tended by surgeons and staff with special equipment and with special experience in dealing with this class of injury. But owing to difficulties in removal in case of fire from air raids, and for other reasons the period of their retention had to be considerably shortened. The other diseases which were definitely retained, and for which special hospitals were detailed, were venereal diseases and infectious diseases. It is interesting to know that the last named required about three per cent of the total number of beds in France for their accommodation. For certain other types of diseases and injuries which it was thought desirable to bring together for more experienced and standardized treatment, special wards in certain general hospitals were detailed. Such were skin diseases, eye injuries, face and jaw injuries, and mental diseases, though the last named were evacuated to England as speedily as possible.

The experience gained in the Great War has abolished the Stationary hospitals, and altered the size of and increased the accommodation in General hospitals, so that these are now of two sizes: (1) A 600 bedded unit including 60 beds for officers, and (2) a 1,200 bedded unit including 120 beds for officers. The scale of supply of hospitals to a force is not laid down in war establishments, but will evidently depend on the length of the lines of communication and the facilities for evacuating to home territories. For a force of one division with army troops, at least two of the smaller units will be required, and probably three, or else one large and one small unit. The two small hospitals will give accommodation for about six per cent of the troops, whilst in one large and one small hospital the percentage will be about nine, which is slightly higher than the pre-war allotment. The smaller unit is intended for use in the neighbourhood of the advanced base, whilst the larger one is located at the base or at some hospital centre.

The medical establishments of the two units are respectively: M.O.'s 19 and 31, W.O.'s, staff-serjeants and serjeants 16 and 25, rank and file 119 and 190, Q.A.I.M.N.S. 50 and 80. It will be seen that the larger unit is much more economical relatively than the smaller one. They are each divided into a headquarters, and a medical and surgical division on the same lines as a fixed peace time hospital, from which they differ little in their principles of administration. In the event of expansion an increase in establishment is authorized per complete 100 beds of M.O.'s 2 and 1, R.A.M.C. 9 and 11, Q.A.I.M.N.S. 4 and 5 respectively. The smaller hospital is therefore better off in this respect, but it feels more the drain on it in providing medical personnel for base and outside duties, which they will both be called upon to furnish. Amongst the M.O.'s are five and six specialists, respectively, including a radiologist and a pathologist; and the larger unit furnishes a surgical team, consisting of 1 surgeon, 1 anæsthetist, 1 Q.A.I.M.N.S. and 1 R.A.M.C. operating room attendant.

As the general hospital arrangements are those of an ordinary hospital, adapted to meet the special conditions prevailing, no description of them is necessary. Much of what has been written regarding casualty clearing stations in a former article is applicable to them, but especial attention must be paid to the arrangements for the reception at one time of large convoys of patients from ambulance trains and M.A.C.'s, and similarly to the rapid evacuation of large numbers to hospital ships, for which procedure special instructions are laid down in Field Service Regulations. The hospitals are complete in themselves in every respect, except in the provision of buildings or huts and transport which are supplied from other available sources. But tents are supplied on mobilization, as well as collapsible wheeled-stretchers, hand-carts and water-carts. Some of the articles supplied to the smaller unit, as, for example, operating tables, are portable. The pathological laboratory, dental, X-ray, ophthalmic and ear, nose and throat equipment is all appropriate and according to special scales. The general equipment of the smaller unit is divided up into that for a "Headquarters" which contains the bulk of it and all central articles, and that for each of two similar sections which is much smaller in amount and variety.

The figures showing the eventual disposal of the patients in base hospitals in France in 1917 are of interest. These show that 14 per cent were sent out as fit for discharge for front line duty to the base depots through the discharge centre, 27 per cent passed to the convalescent depots 3 per cent were fit for P.B. men, making a total of 44 per cent retained in the country; whilst 55 per cent were evacuated to home territory, and 1 per cent died.

Convalescent Depots.

F.S.R., vol. i, states that these "are intended for officers and men who require no further active medical or surgical treatment, and who, although not yet fit for duty, are likely to become so in a reasonable time." With the original expeditionary force only one convalescent depot of 1,000 beds was mobilized, and its staff consisted of two M.O.'s, a quartermaster and three R.A.M.C. other ranks. The depots however increased rapidly in number, but they were at first only organized as overflow units to relieve the congestion of the L. of C. or base hospitals and to treat until fit for duty the lighter cases not yet sufficiently recovered to rejoin their units. It was not till the latter half of the war, that the depot as it is known to-day, was developed and organized, though its extreme value in the saving of man power for the Army had come to be well recognized. And with the new unit came considerable changes in its functions, so that it was no longer merely a hospital overflow, but was expected to play an active part in restoring men to full fitness of both mind and body, by training and exercising them without an irksome discipline.

The advantages gained by the employment of these units are many. They retain their original *raison d'être* of acting as overflows to hospitals

in the event of congestion of the latter and thus enabling them to provide at short notice a considerable number of vacant beds which are required on the eve of commencing operations. But in addition to this they save many men for their units who would otherwise be evacuated to the base or to home territories, and who would not return for a considerable amount of time. They save expenditure of transport and the extra work otherwise thrown on the railways or other system of ambulance carriage. They complete the physical healing of the man by improving his mental and moral outlook, so that he leaves them with higher ideals, stronger in *esprit de corps*, and with his *moral* restored.

The present-day unit is authorized for 2,000 convalescents, and two units are mobilized per corps of three divisions. Each unit consists of a headquarters and two divisions, each division being sub-divided into four companies of 250 men each. The staff consists of ten officers, sixteen W.O.'s, sixteen staff-serjeants and serjeants, and sixty-two rank and file. The medical side is represented by a lieutenant-colonel, as officer commanding the depot, a captain or subaltern as registrar, a dental officer, a major in charge of one division and a captain in charge of the other, together with one serjeant dispenser and four rank and file R.A.M.C. for the detention hospital. The headquarters is responsible for the administrative work, and controls the orderly room, guard room and police, pay duties, dining hall, cookhouse, quartermaster's stores for equipment, clothing and supplies, bath, laundries, disinfection, conservancy and fire arrangements, recreation rooms, churches and church rooms (three chaplains are attached), band and entertainments, gardens, serjeants' mess and officers' mess, in addition to the detention hospital and dental work. The divisions carry into effect the training work and the placing of men in different categories according to their fitness, re-classification being carried out once or twice weekly. As regards the non-R.A.M.C. regimental staff, these are chosen from officers and men who are classified as somewhat less than A1, but they must be suitable for their duties and be fit both physically and morally, tactful, good disciplinarians, capable instructors in P.T. and bayonet exercises, and able to lead and command men. They are usually taken from those who have had front line service. The medical officers must be of "A" category, and fit in every respect.

The accommodation on mobilization is in double fly bell tents, eight men to a tent, with marquees for hospital, dining and recreation room, etc.; but huts may be supplied in lieu, in which case sixteen Nissen huts for sixteen men each per company are needed, in addition to headquarters requirements.

The length of stay in the depot varies from two to six weeks. The convalescents come from the neighbouring hospitals. It is found that a certain number, about 12 per cent., have to be sent back for further treatment. The majority, about 76 per cent, are passed on when fit (after an average stay of four weeks) to the base depots, for re-equipping and

return to duty in the front line; the remaining 12 per cent consisting of men not considered fit for front line work are passed on to be dealt with by a medical board, and the bulk of these become the permanent base men, and are utilized for work at the base depots on the L. of C., and as batmen, etc. In practice it is found that a number of the patients up to 10 per cent have to be employed on administrative work of the depot; and as a rule there is competition for this, as it gives those selected an extra week's stay in the depot. But in the last week at least they should undergo vigorous P.T. exercises to complete their hardening.

There are certain considerations which should be taken into account when choosing the locality and site of a depot: (1) It should be in the vicinity of general hospitals. If there is a general hospital at the advanced base, a convalescent depot should be there also, though occasionally one is located in the vicinity of a C.C.S. group, so as to save the lighter cases from being evacuated out of the army area. (2) It should be easy of access to the hospitals and to the base depots. (3) It should be easy of access for food supplies and stores. (4) Railway facilities should be available. (5) Its site should be healthy and its surroundings congenial. The ideal site is on a hill near the sea and within two to three miles of a town. (6) It should have plenty of space and not be cramped, and should be furnished with playing grounds and ample means of recreation and mental occupation. The importance of items (5) and (6) cannot be over estimated. The creation of an atmosphere of mental interest and an occupation which is looked on as amusement or recreation rather than as work goes a very long way towards restoring the vigour of the men. For this reason inter-company or inter-divisional competitions in sports and boxing play an important rôle; for indoor amusements, draughts, billiards, whist and bridge will each attract a number of men; and a very large number take a deep interest in intellectual lectures and discussions, and in the study of languages, history and drawing. Others of a practical turn of mind find their interest in workshops, whilst the majority are ready to listen to suitable propaganda of current events.

In fine, the rôle of the convalescent depot lies in the completion of the healing process of the hospitals and in the restoration of health and vigour to both body and mind.

A CRITICAL REVIEW OF THE PRESENT POSITION OF BACTERIAL AGGLUTINATION.

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(*Continued from p.* 368).

VII. Physico-Chemical Considerations.

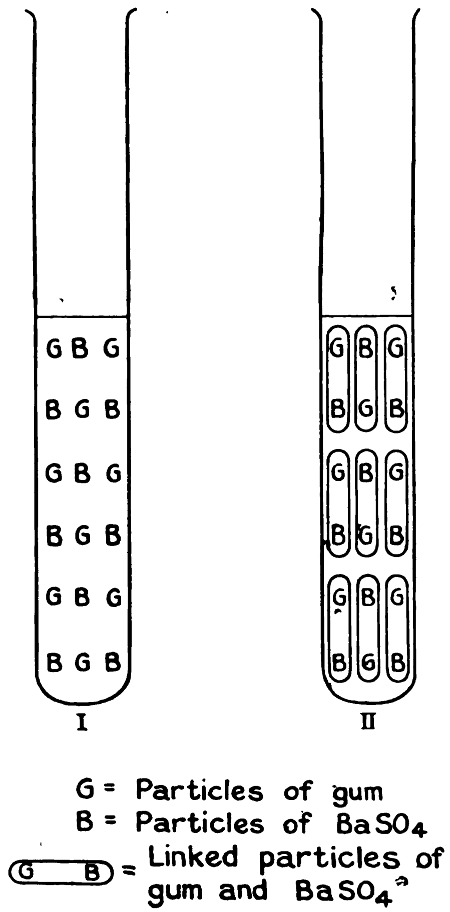
It may justifiably be urged that the various criticisms of the receptor analysis method which have been brought forward in the previous sections of this paper are solely destructive, and unless something constructive can be suggested to replace the views that are at present held, such criticism loses much of its value.

It is in the field of physical chemistry that one may hope to find satisfactory explanation of the various phenomena of immunity, but it must be admitted that, so far, no great generalization based upon physical chemistry and serving to explain the many problems of the subject has been made.

Nevertheless, although the results of research in physical chemistry as applied to immunology have been somewhat disappointing, much work of a valuable nature has been carried out, notably by Bordet and his associates, and more recently by Northrop and De Kruif [36]. This work, although it fails to explain many of the problems met with, is of extreme value, in that it calls attention to the importance of the physical conditions of the interacting substances in all sedimentation and lytic experiments performed *in vitro*.

The following simple experiment, quoted from Gengou [37], is instructive and has a bearing upon the subject of receptor analysis, especially that aspect of receptor analysis which is based upon the thermo-stability and thermo-lability of antigens. If $BaSO_4$ be added to distilled water the insoluble salt rapidly sediments under the influence of gravity enhanced by the mutual attraction which the particles of the salt have for one another, but on adding $BaSO_4$ to a solution of gum arabic the suspension is stabilized. This stabilization is not due to increased viscosity of the menstruum, but is due to the formation of a loose linkage between the gum and the particles of $BaSO_4$. On centrifugalizing such a mixture the deposit obtained can be washed several times, and yet after such washing it gives a stable suspension when shaken with water. Moreover, the supernatant fluid from the first centrifugalization will not stabilize a further quantity of $BaSO_4$. What has happened is that the contents of the test-tube—

water, $BaSO_4$, and gum—in place of forming a simple mixture which could be diagrammatized as in I, have distributed themselves so that they are arranged as in II. So that, although the contents of I and II are the same the distribution of these contents is different. If, now, tube II be heated the loose linkage of $BaSO_4$ and gum is broken and the contents of tube II are now distributed as in I, so that if tube II be centrifuga-

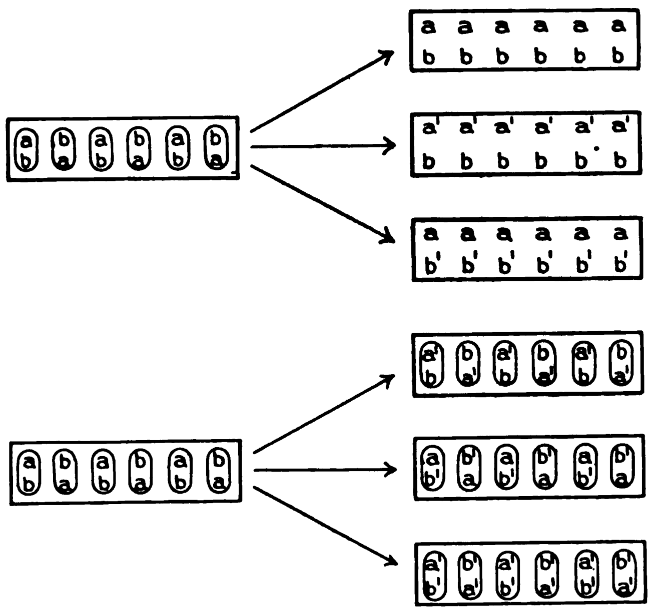


lized while still hot and the supernatant fluid removed, such fluid is found to have a stabilizing effect on suspensions of $BaSO_4$, although, if centrifugalized while cold, the supernatant fluid does not exhibit this stabilizing effect. Heating has therefore a profound influence upon the reaction of the constituents of what appear to be very simple mixtures, and such alteration in reaction is not dependent upon chemical change in, but merely upon redistribution of, the constituents of the mixtures.

Bacterial protoplasm, although at first sight it may appear to be homo-

geneous, is probably not so. Thus, apart altogether from the obvious analogy with other living structures, whose protoplasm is obviously not homogeneous, we have evidence in the peculiar staining reactions of flagella, capsules, granules, etc., that bacterial protoplasm is not homogeneous. The structure of bacteria is probably complex and made up of a number of different colloidal substances loosely linked together so that the influence of external agents, e.g., heat, upon such a system cannot be foreseen.

For purposes of discussion let us suppose that in an unheated micro-organism two colloids (*a* and *b*) are linked together, then on heating that



"a'" indicating that colloid "a" of the untreated organism has undergone change of a permanent kind on exposure to heat or other influence; "b'" indicating that colloid "b" has suffered similar alteration.

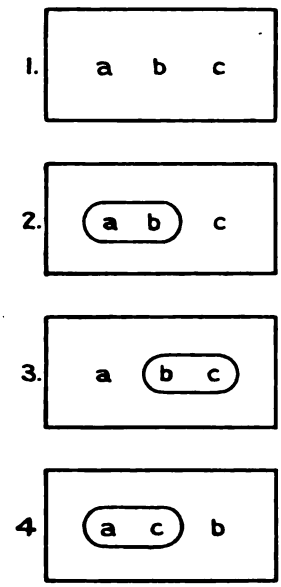
micro-organism that linkage may be broken, just as occurs in the case of a simple mixture of $BaSO_4$ and gum. The heated organisms might react in a manner very different from the unheated organisms, and either, or both, of the colloids may be altered by heat, or their linkage might in certain circumstances be permanently broken. These alterations could well explain the difference between the reaction of heated and unheated micro-organisms, and could be expressed pictorially thus: $a\ b$ in the unheated micro-organism might be changed into $a + b$ on heating, or into $a^1 + b$, or $a + b^1$, or $a^1 + b^1$, etc.

Three such possibilities are shown, the transposition of the lettering being used to signify the breaking of a colloidal complex present in the

untreated organism; or new complexes might be formed between the *altered* colloids.

The same essential substances would be present in all these, but their re-arrangement might result in marked difference of reaction. It must be clearly understood that the above diagrams are not intended to serve as an explanation of observed phenomena, but are merely employed to render the text more easily followed.

So far we have considered the simplest hypothetical case, and it is not improbable that the conditions in organismal protoplasm are very much more complex. To illustrate this, let us consider what may happen if three colloids are present. In the normal unheated organism these colloids *a*, *b* and *c* might be distributed in any of the following ways.



On heating, or under adverse conditions of culture, and assuming that no alteration occurs in the colloids themselves as a result of exposure to heat, etc., we may have the distribution of any one type, 1, 2, 3, or 4, of above diagram changed into any of the other three distributions, i.e., from one indivisible whole consisting of mixtures of three colloids we may obtain four different distributions of the essential constituents, which re-distribution could possibly, and would probably, result in four different types of reaction.

If heat, or other influence, were to affect permanently the physical state of the constituent colloids, in addition to influencing their linkage, then the number of possible variations becomes indeed formidable, and should explain the difficulties that have arisen from study of the lability and stability of antigens by serological methods. These are, however, merely hypotheses,

and, while they could in some circumstances serve to explain certain observed facts, they may have no bearing upon what actually occurs during the process of agglutination, and are therefore only of academic interest.

The most definite advance which has recently been made in the study of the physical-chemistry of agglutination is due to Northrop and De Kruif [36], who, in a series of papers, deal with the process of flocculation, and the process of union of antigen with antibody. The process of flocculation is shown under certain circumstances to depend upon two factors: (*a*) The electrophoretic potential of the particles to be clumped, and (*b*) the cohesive quality of the particles.

In the process of acid-agglutination (i.e., agglutination in absence of antiserum which occurs in menstrua of a certain range of acidity) the electrolyte of the suspending fluid influences both these factors thus:—

(1) Increase, to a certain point, in concentration of the electrolyte reduces the electrophoretic potential of the particles and so tends to make these flocculate.

(2) Increase in concentration of the electrolyte at the same time reduces the cohesive force of the particles and so tends to inhibit their flocculation.

The first of these factors is marked when the electrolyte is present in low concentration (0·01 to 0·1 N), and the second when it is present in high concentration (greater than 0·1 N). Acid agglutination can, therefore, be inhibited to a greater or less extent by performing the reaction in presence of electrolytes of high concentration.

In this connection attention is called to Table XIV, in which it is seen that exposure to a temperature of 95°C. for thirty minutes of a rough strain of *B. paratyphosus* B, which is precipitated in presence of 2/10 M NaCl, markedly increases the stability of its suspensions over the range M to 6/10M NaCl.

The exposure to heat has apparently altered markedly the cohesive quality of this rough suspension. In the same experiment a similar but opposite result is seen in the case of a smooth specific strain of *aertrycke* bacillus.

It would seem, then, that in the process of flocculation alone, apart altogether from flocculation in presence of antisera, we have to deal with a balancing of opposing forces, and that the balance is struck under very different conditions according to the nature of the particles to be flocculated.

The authors quoted show, however, that organisms which have been exposed to their appropriate antiserum differ from unsensitized organisms of the same kind in that the reduction of their electrophoretic potential to + or − 15 millivolts is the only factor affecting their agglutination, i.e., increased concentration of salt does *not* lessen the cohesive force of sensitized organisms in the same way as it does that of unsensitized organisms.

It is to be noted that if the organisms are not *completely* "sensitized" the anticohesive effect of strong salt solution becomes manifest, and, from

quantitative observations concerning (*a*) the concentration of salt, and (*b*) the concentration of serum necessary to produce *complete* agglutination, it is estimated by Northrop and De Kruif [36] that complete agglutination can occur when the surface of the micro-organisms is about "one-eighth covered" with serum, and that the anti-cohesive action of strong salt is completely inhibited when the surface of the micro-organisms is completely "covered."

The conclusion to be drawn from this observation is that the union between an organism and its antiserum is an adsorption phenomenon, the serum spreading itself at the interface between the particles (organisms) and the menstruum in which they are suspended. This is borne out by the fact that specific immune body can be separated *completely* from the organism with which it has combined provided that the mixture be sufficiently washed with distilled water. Moreover, in such experiments, it was found that although *some* of the immune body was easily removed, the remainder could be separated from its antigen only with difficulty; a striking analogy with what obtains when one attempts to remove films of gas adsorbed on surfaces. It is also worthy of note that the quantity which presented difficulty in removal was the equivalent of about twelve agglutinating doses—a figure which, considering the difficulties of mensuration, gives a fair approximation to the estimate of these authors that a complete film of immune serum is the equivalent of about eight agglutinating doses. Moreover, the amount of antiserum required to produce complete agglutination varies directly with the concentration of the suspension.

These findings can be explained most satisfactorily on the hypothesis that the antibody forms a film on the surface of the micro-organism and thereby protects it from the anti-cohesive action of salt.

There is also evidence which shows that the organism with its layer of serum takes on the character of the added layer, so that the behaviour of antibody-antigen complex would be predominantly that of the attached antiserum.

The hypothesis may be advanced, then, that the process of agglutination by specific serum depends upon three factors:—

(1) Formation of a layer of antiserum around the micro-organisms.

(2) Resultant protection of the micro-organisms from the anti-cohesive action of salts.

(3) Reduction of the electrophoretic potential of the particles to + or − 15 m. volts.

In considering these factors the following points have to be noted:—

(i) The formation of a layer of antiserum around its antigen is bound up with the all-important, but elusive, question of specificity. It is this extraordinary specificity that so strongly suggests a chemical explanation of the mutual attraction between antibody and antigen. The experimental findings, however, concerning the union of toxin with antitoxin, of agglutinating sera with particles to be agglutinated, and of lytic antibody with

substances to be dissolved, all suggest a physical union rather than a chemical combination.

(ii) With regard to the view that the action of antibody is that of protecting the organisms from the anti-cohesive influence of salt, the following calls for consideration:

It must be observed that if the view be that this effect is *solely* protective, then we should expect that the particles of serum would precipitate in presence of electrolyte under the same conditions as do organisms covered with their layer of attached antiserum, i.e., the small colloidal particles of the serum would not be influenced by the anti-cohesive action of salt as are bacteria. There is no evidence of the formation of precipitates when serum is diluted in, e.g., saline, and unless the precipitate be invisible we must conclude that the "attached" serum, which forms a layer around sensitized organisms, exhibits physical properties different from those of "unattached" serum.

It is possible, nay, even probable, that a change does occur in the serum when it forms a layer around micro-organisms, for exposure of a solution of soap to oil films removes so much soap from the watery solution, condensing the soap at the interface between the oil and solution that, at the interface, the soap can be visualized only as a *solid layer*. Probably intense condensation of this kind is accompanied by loss of water from the soap particles, and a similar process may occur in the covering layer which appears to form around micro-organisms exposed to homologous antiserum.

If a similar process occurs in the process of sensitization then it is possible that the colloidal particles of the "unattached" serum, carrying much water, behave as non-rigid colloids, while the condensed particles of the "attached" serum, having lost water, behave as rigid colloids.

The suggestion is that the layer of "attached" anti-serum acts not solely as a protection from the anticohesive action of salt, but also that the particles of this layer undergo some change through being condensed upon the antigen, and that this change increases their precipitability.

If such change does occur it is certainly not dependent upon the organism being alive, for killed suspensions of bacteria agglutinate as readily as do live suspensions. It does not appear to be due to enzyme action on the part of the antigen, for antisera can be prepared for antigens that have been boiled, and it is apparently not due to chemical union between antigen and serum, for the serum can be separated by the simple process of washing with distilled water.

We are therefore forced to the conclusion that if a change does occur in the serum, which appears to form a layer around sensitized micro-organisms, that change is almost certainly a purely physical change and is very probably of the nature of a condensation.

It would be interesting to know whether that moiety of serum which can be separated from sensitized organisms (the strongly adherent eight agglutinating doses) only by prolonged and frequent washing exhibited

different physical characters from that which can be easily removed (over twelve agglutinating doses) by the same procedure. The investigation of this presents technical difficulties, but an attempt is at present being made in this laboratory to conduct experiments on the subject.

(iii) The reduction of the electrophoretic potentials to + or − 15 millivolts. According to the work of Northrop and De Kruif [36], agglutination will not occur when micro-organisms carry a greater charge than + or − 15 millivolts. This statement, however, is not strictly accurate, for the finding applies only to experiments in which certain electrolytes were used and, if other electrolytes—e.g., Na_2HPO_4 (Shibley)—be employed in the reaction, flocculation in the presence of immune serum may still occur when the potential is as high as 34·5 millivolts. As previously noted, Shibley also established the fact that agglutinating immune serum possesses specifically the power of reducing the charge upon micro-organisms, and it is to be noted that this is associated definitely with agglutination, for a serum able specifically to protect against a given infection, if it be devoid of agglutinating power, is also devoid of this charge-reducing influence.

In view of these observations the hypothesis under discussion might be modified thus. That the process of agglutination by specific serum depends on the following factors:—

(*a*) Formation of a layer of antiserum around the micro-organisms.

(*b*) Alteration of the precipitability of this layer of adsorbed serum; along with this there occurs a reduction of charge carried by the micro-organisms and this reduction of charge is specific.

(*c*) Protection of the micro-organisms from the anticohesive action of salt.

(*d*) In some, but not in all, circumstances, reduction of the electrophoretic potential of the micro-organisms to + or − 15 millivolts.

In the majority of instances in which a micro-organism is exposed to appropriate agglutinating serum all four hypothetical factors would operate, but it is conceivable that circumstances interfering with one or more of them might arise, excepting (*a*), which is absolutely necessary, for if antibody fail to be attracted to antigen nothing further can occur. Indeed, all immunology is based upon the assumption that union of antigen to antibody must occur if these be brought into contact with one another under suitable conditions. In the case of an inagglutinable strain of a micro-organism, we might be dealing with conditions in which factor (*b*) or (*c*) or (*d*) was abnormal. We should have union of antigen and antibody so that adsorption of antibody would occur, but visible agglutination would not take place. The organism on inoculation would give rise to antiserum which might fail to agglutinate itself, but, none the less, would agglutinate other strains of the same species. This would explain the reactions of inagglutinable strains such as that described by McIntosh and McQueen [38]. Such strains are of interest as showing that antigens may vary markedly in their reactions, and a study of these by the methods employed

by Northrop and De Kruif [36] would possibly give valuable information as to whether the hypothesis just advanced serves adequately to explain the process of agglutination by immune serum. It might be found that one inagglutinable strain was inagglutinable because factor (*b*) did not operate; another, because factor (*c*) or factor (*d*) did not operate.

Thus, in the case of the bacillus studied by McIntosh and McQueen [38], it was found that so far as acid-agglutination was concerned the inagglutinable strain did not differ from ordinary normal agglutinable strains; presumably, therefore, factor (*d*) was not at fault. The absorptive capacity of the inagglutinable strain, tested quantitatively, was as great as that of the normal agglutinable strains; therefore factor (*a*) was not at fault. By a process of exclusion, then, it appears that factor (*b*) or (*c*) was wanting. As, however, the micro-organism possessed normal absorptive capacity, it seems improbable that the (hypothetical) layer of absorbed serum would be devoid of protective action against the anti-cohesive action of salts; so that, therefore, one would not think that factor (*c*) was wanting in this instance.

On the original hypothesis, then, of there being only three factors responsible for agglutination, the behaviour of the inagglutinable strain under discussion could not be readily explained. This constitutes an argument for the probable acceptance of the additional factor (*b*) of the modified hypothesis, and, if we accept the modified hypothesis, suggests that the physical state of the antigen plays an important part in determining the quality of condensation of immune serum upon its surface. In this connexion it is interesting to note that McIntosh and McQueen [38] found that washing of their inagglutinable strain, after exposure to homologous serum, resulted in greater liberation of agglutinin than did similar treatment of sensitized normal strains.

Reverting to the subject of the importance of the electrophoretic potential it is to be noted that Northrop and De Kruif showed clearly that a rough strain of the bacillus of rabbit septicæmia carried a lower charge than did a smooth strain.

Similar differences were noted by Falk and Jacobson [39] to exist between smooth and rough variant cultures of Type I pneumococcus and between single-cell isolations from these variant cultures. The isolations from single cells as well as the parent whole cultures remained true to type over a prolonged period, but should the rough type, of low virulence and carrying a low charge, on inoculation into mice produce death of the animals, only smooth cultures of higher virulence and carrying a high charge are obtained from the heart blood and peritoneal exudate. *This is so even when the rough culture has been derived from a single cell.* The importance of this observation is very considerable in view of the tendency which has recently become manifest to found theories of bacterial genetics upon observations of smooth and rough variants of the same micro-organism.

That a definite relationship exists between electrophoretic potential and agglutinability of pneumococci in presence of certain electrolytes is shown by Falk and Jacobson [40] who found that by washing smooth and rough variants of Type I pneumococci the following results could be obtained :—

Unwashed Type I pneumococci.

Smooth colony: electrophor. pot. high, did not readily agglutinate.
Rough colony · electrophor. pot. low, agglutinated readily.

Washed Type I pneumococci.

Smooth colony : electrophor. pot. relatively low, agglutinated readily.
Rough colony: electrophor. pot. relatively high, did not readily agglutinate.

The process of washing, then, had entirely altered the reactions of these micro-organisms, producing, indeed, a reversal of certain of their characters.

On the above hypothesis, then, some of the apparent anomalies of agglutination can be explained :—

(1) The first difficulty that we encountered, viz., failure of heated flagella to act as antigen *in vitro,* although active *in vivo,* is an extreme example in which even union of antibody with antigen is inhibited owing to excessive change in the physical state of the latter, although, on inoculation, such antigen can still stimulate production of agglutinins.

(2) The instance in which an organism gave rise to agglutinins which it could not absorb is another extreme example of the same thing.

(3) Less extreme examples are to be found in the difference between the quality of the clumping under different conditions—floccular and granular—agglutination of smooth strains and of rough strains, and possibly the diaphasic variation of the Salmonella bacilli. For this reason, then, the physico-chemical hypothesis of agglutination is worthy of serious consideration.

Another aspect of the question is dealt with by Scheller [41], who found the following :—

(1) If mixtures of agglutinating serum and homologous micro-organism be vigorously shaken the clumping of the micro-organisms is markedly reduced, and in some circumstances completely inhibited.

(2) If to suspensions of sensitized organisms, stabilized by shaking, there be added :—

(*a*) More antiserum, no agglutination occurs.

(*b*) Unsensitized bacilli, complete agglutination occurs.

(3) Shaking of the serum and organisms separately had according to Scheller no influence upon their subsequent behaviour, but this is not strictly accurate, as has been shown by work at present proceeding in this laboratory.

(4). On shaking mixtures of serum and organisms, although no agglutina-

tion took place, absorption of agglutinins occurred apparently to the same extent as when the procedure was permitted to take place in the ordinary way. In one experiment, indeed, there was a suggestion of more complete absorption of agglutinins in the shaken mixture than in the unshaken controls.

(5) On mixing serum and organisms :—

(*a*) If the mixture were not shaken complete agglutination occurred.

(*b*) If allowed to stand for five minutes, then shaken vigorously for one minute, partial agglutination occurred.

(*c*) If allowed to stand for ten, twenty, or thirty minutes and then shaken vigorously for one minute, no agglutination occurred.

These findings are interpreted thus : That in the process of specific agglutination a precipitate is first formed by union of the antibodies of the serum with some substance which has diffused from the micro-organisms. This precipitate entangles the bodies of the micro-organisms, so giving visible flocculation.

If the tube be shaken sufficiently vigorously the precipitate is dispersed and a stable suspension results.

This interpretation is open to the criticism that although in some instances there is evidence of the formation of precipitates (i.e., precipitation apart altogether from clumping of bacteria or cells) in agglutination reactions, there is no evidence that such precipitation is of constant occurrence or is a necessary preliminary to agglutination.

There is a striking analogy between the stabilization of suspensions of sensitized organisms and the inactivation of complement by shaking, so that an alternative explanation presents itself, viz., the complex "organism + serum" undergoes a physical change when vigorously shaken, and the complement when similarly treated undergoes modification of a kindred nature. It is worthy of note that sensitized organisms, which have been stabilized by shaking, rapidly agglutinate on the addition of complement; a finding which recalls the phenomenon of con-glutination described by Bordet [42]. It would be of interest to determine whether the addition of complement, inactivated by shaking, to stabilized sensitized micro-organisms had the same influence as active complement added to the same suspension. Work on this subject is at present proceeding.

Scheller's experiments, even if we do not accept his own interpretation of them, call attention to the importance of the physical state of the interacting substances in the process of specific agglutination, and are extremely suggestive, but, unfortunately, were carried out without attention being paid to quantitative observations as would be the case were these tests carried out at the present time.

Summary.

The physico-chemical methods of inquiry have shown that the physical factors in agglutination, both non-specific acid agglutination and specific agglutination in presence of immune serum, are of importance, and even

of preponderating importance in determining the quality of, and even the occurrence of, clumping. A physical hypothesis, mainly based upon the work of Northrop and De Kruif but slightly modified, is advanced as an explanation of, and as a starting point for further investigation into, the process of agglutination.

CONCLUSION.

In the present state of ignorance it is inadvisable to employ the procedure known as receptor analysis in order to investigate bacterial genetics and the antigenic relationship of micro-organisms to one another. The use of the procedure involves the assumption that each reaction observed is referable to a separate constituent of antigen and a separate moiety of antibody. There is no evidence whatsoever that this assumption is valid.

Arguments concerning bacterial mutation based upon the method are, therefore, open to criticism, and the work of Falk and Jacobson with single-cell isolations of pneumococci appears to show quite definitely that the change, from smooth to rough at least, is in no way fundamental.

Correlation of chemical with serological methods is not complete, but such correlation as there is tends to show not that each reaction is referable to a separate constituent of antigen and a corresponding separate constituent of antibody, but that one antibody can react to a greater or less extent with several antigens.

Physico-chemical factors play an extremely important part in determining the characters of agglutination, and this reaction, apart from specificity, can be explained on a purely physical basis.

As a final observation on the present position, one cannot do better than quote Manwaring [43] : "It is even conceivable that the wide acceptance of the Ehrlich theory by surgeons and clinicians, and the prominence given to this theory in elementary textbooks of bacteriology, constitute to-day our most serious handicap to immunological progress.

"I think we would win the endorsement of physiologists and pharmacologists if we would quietly lay aside for future reference the entire scheme of immunology based on the specific receptor hypothesis, and would begin anew at the very beginning to unravel the mystery of the origin and nature of antibodies, directing our attention, first, to problems relative to the normal and pathological permeability of fixed tissues and wandering cells for immunological antigens; and, second, to problems relating to the interplay of antigens with extracellular and intracellular hydrolysing and synthetising enzymes."

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Editorial.

THE REPORT OF THE MEDICAL RESEARCH COUNCIL.

THE report published by the Medical Research Council for the year ending, September 30, 1926, presents a survey of the work done under the auspices of the Council by the large number of investigators whose researches are organized and, to some extent, subsidized by the Council.

In the introduction to the report, the general policy with regard to the encouragement of and assistance to research is explained. It is pointed out that the Council is not wholly responsible for gaps in the total programme of work. "Financial assistance can have, and has had, inestimable value in promoting research work, but it cannot always command it. Successful research work at the growing points of knowledge can only be done by men of the first quality, and their success is only reached through freedom." On the other hand, the Council acknowledge their obligation to promote definite utilitarian ends in their expenditure of public funds, but emphasize that it is impossible to foretell the ultimate applicability of any scientific investigations. What at one time appears to be merely the academic work of the laboratory may later on become of immense practical importance. As an illustration of this, the progress of research in connexion with histamine is reviewed. This substance is derived from protein constituents of the body, and, shortly before the war, it was shown to have the power of causing contraction of involuntary muscle when applied in extremely small quantities. During the war it became clear that the grave symptoms of shock supervening after severe wounds or extensive surgical operations closely imitated the effects that histamine can produce; and the mechanical destruction of the body tissues is precisely a condition likely to yield it as a breakdown product. This similarity opened up a channel for the study of the conditions seen in cases of shock as reproduced in animals by the administration of histamine. Experiment showed that it had the further property of causing loss of "tone" and increased permeability of the capillaries. This observation threw great light on the phenomena of shock, and contributed very largely to the successful treatment of the condition. Recent work promises to have still more practical applications.

Another example cited is the case of the academic study of the chemical structure of the sterols, the most familiar of which is cholesterol. When it was discovered that vitamin D could actually be formed when cholesterol was exposed to the rays of ultra-violet light, the study of this most im-

portant subject would have been greatly delayed had it not been for the previous knowledge of the chemistry of the sterols.

In further illustration of their point the Council refer to the history of insulin, the relationship between vitamin D deficiency and dental caries, and to the important field of research in connexion with filter-passing viruses.

The next section of the report deals with the activities of the National Institute for Medical Research at Hampstead, with its associated Farm Laboratories at Mill Hill. Extensions to the latter have been completed, in which Mr. Barnard will have improved facilities for carrying on his work on cancer in close touch with Dr. Gye. This research has been continued, and Dr. Gye has found no reason to modify his previous position. The great interest aroused by his work has naturally attracted a number of observers, but it cannot yet be said that his theories have been confirmed or disproved. On questions of fact some laboratories have confirmed and some have failed to confirm portions of his work.

At the Institute also considerable progress has been made with regard to biological standards, in special preparation for its coming responsibilities under the Therapeutic Substances Act. The British Standard of Diphtheria Antitoxin has already been distributed and the preparation of the British Standard of Tetanus Antitoxin is approaching completion under the direction of Dr. Hartley, who has also found a method by which ninety-nine per cent of the impurities present in crude diphtheria toxin-antitoxin mixtures can be removed.

Since the report is in itself a brief review of the many activities in which the Council is interested it would be impossible in the space at our disposal to allude to more than a very few examples. Among those which may be of peculiar interest to our readers is the work of Professor E. Mellanby on food-substances in relation to vitamins. He has made further studies with a view to finding the nature of the constituent of cereal foods which, in the absence of enough calcifying vitamin D in the diet, interferes with proper bone formation. Many of the physical and chemical properties of this constituent have been determined and it is now possible to treat cereals so that their power to interfere with calcification is reduced or abolished. The property of a certain form of wheat germ to affect nerve function when eaten in diets deficient in fat-soluble vitamin has been further investigated and a condition similar to multiple combined degeneration of the spinal cord has been produced experimentally. The production of nervous lesions by a food rich in vitamin B seems to indicate the presence of some positively harmful agent (termed "toxamin" by Professor Mellanby), and the discovery of its possible existence in normal foods makes an important addition to our knowledge.

In the work on tuberculosis, Professor S. L. Cummins has found that treatment with sanocrysin can eliminate the milder infections in rabbits, but that it is without avail in heavy infections with more virulent strains.

The Tuberculin Sub-Committee find that the double intradermal test is definitely superior to the subcutaneous test when applied to dairy cattle under field conditions.

At St. Mary's Hospital, Sir Almroth Wright has continued the study of non-specific responses elicited by vaccines and other agents and has devised many new laboratory methods. In the same institution, Dr. Leonard Colebrook, working on infections by hæmolytic streptococci, has evolved some improvements in treatment by immuno-transfusion and has made important contributions to our knowledge of the treatment of these infections by means of arsenical compounds of such low toxicity to human tissues that they can be injected at frequent intervals.

The research on the physiology of vision is of particular interest since so many industrial processes are dependent on visual acuity. The effects of glare, flicker and various methods of illumination are being studied, while a sub-committee has had the consideration of the special problems of the fighting services. Major J. H. Gurley has conducted an inquiry into the relation between visual acuity and shooting records, while the factors influencing efficiency in the use of range-finding apparatus have been studied by Commander M. B. Macleod.

Under the heading of epidemiology we find reference to the question of "herd-immunity," studied experimentally in semi-isolated communities of mice by Professor Topley and Dr. Greenwood, and statistically by Surgeon Commander S. F. Dudley. This sphere of research is of peculiar interest to medical officers of the Army, and some aspects of it were recently considered in this Journal under the heading of "Droplet Infection."

In the field of the more directly utilitarian investigations many workers have been engaged on such problems as dust inhalation and pulmonary disease, spirochætal jaundice in South African mines, the physiology of muscular work and industrial psychology.

The concluding section of the report records the appointment of Sir Frederick Hopkins, F.R.S., and Professor C. J. Martin, C.M.G., F.R.S., to the vacancies in the Council caused by the retirement of Professor T. R. Elliott and the death of Sir William Leishman, whose services to the Council are acknowledged in a fitting manner.

The index of names and subjects at the end of the report and the lists of papers given under their appropriate headings in the body of the report afford a convenient method of reference to the detailed accounts published by the various investigators.

Clinical and other Notes.

A CASE OF PNEUMOCOCCUS SEPTICÆMIA.

By Captain E. O. A. SINGER.
Royal Army Medical Corps.

HAVING read Colonel J. C. Kennedy's account of four cases of meningococcus septicæmia in the July, 1926, number of the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, I should like to give a short description of a case of pneumococcus septicæmia which, though far less uncommon, yet exhibited certain features of interest.

Rifleman C., aged 23, was admitted to the British Station Hospital, Rawalpindi, on February 24, 1925. He had felt out of sorts on the previous day, and was detained in hospital. On the evening of this day he had a rigor; a blood-film taken at the time was negative for malaria parasites.

On admission, he complained of severe headache, pain in the back and also pain along the upper border of the liver when coughing. There was a moderate amount of cough. The bowels were constipated. There had been no vomiting, no coryza, no sore throat, and no epistaxis. His previous history was negative as regards malaria, dysentery, or any other disease of importance.

The temperature on admission was 100° F., pulse 88, respirations 26. The face was flushed and the tongue furred. No signs of respiratory distress. The heart, liver, spleen, and abdomen generally showed no abnormality.

Lungs: Left, nil to note; right, moderate dullness at the right base posteriorly; bronchial breathing; a few crepitations; vocal resonance increased and slightly ægophonic. There was a little viscid, blood-stained sputum, and a provisional diagnosis of lobar pneumonia was made.

February 25, 1925: Patient slept well during the previous night, but still complained of a violent frontal headache on waking. Temperature this morning 103° F., pulse 100, respirations 24. Blood-pressure: systolic 114, diastolic 64. Face flushed and tongue heavily furred; general appearance apathetic. As the severe headache pointed to a possible meningeal involvement, the nervous system was carefully examined, but no abnormality was discovered. There was no head retraction or rigidity. The urine showed no abnormality. A second blood-film was negative for malaria.

Report on the sputum: The majority of organisms present were catarrhal. A few pneumococcus-like organisms were present. Tubercle bacilli were absent. The severe headache and the comparatively slight

involvement of the lung having raised doubts as to whether the case was an uncomplicated pneumonia, a sample of blood was taken in bile-salt medium, as at this stage it was thought the case might possibly be one of enteric fever with so-called pneumonic onset. The culture medium was subsequently returned as sterile. A specimen of blood for a Widal reaction was taken at the same time, so as to obtain a "resting value" of the agglutination titre. This showed merely an agglutination such as might be expected in a person inoculated with T.A.B. vaccine within a year.

February 26: Patient slept well during the previous night, but still complained of frontal headache. The morning temperature was 102·6° F., pulse 104, respirations 30. There was no change in the physical signs.

Report on a second specimen of sputum was similar to that on the first specimen.

February 27: Patient did not sleep well during the previous night in spite of the administration of morphia $\frac{1}{4}$ gr., and atropine $\frac{1}{100}$ gr. The morning temperature was 102·4° F., pulse 116, respirations 32. Headache slightly improved. Patient still constipated, abdomen distended and tongue dirty.

Lungs: Left, percussion note at the base was impaired; there were some crepitations, but no typical bronchial breathing. Right, no marked change as compared with first day, except that the dullness extended a little further forwards into the right axilla.

February 28: Complete insomnia previous night. The morning temperature was 99° F., pulse 100, respirations 48. Patient looks very ill. Headaches severe. Some photophobia, slight twitching of face muscles, and slight rigidity of neck. Kernig's sign negative and no rigidity of limbs. Patient mildly delirious; moderate incontinence of the bladder. No hæmorrhagic lesions or other eruptions on the body.

The bowels did not act except as the result of an enema given on the previous day; abdomen distended.

Heart: No abnormality noted. Blood-pressure: Systolic 140, diastolic 80. Lungs: Left, pleural friction at base posteriorly; otherwise no change. Right: No change. Urine: No abnormality.

A blood-film taken on the previous day showed a small Gram-positive diplococcus in moderate numbers.

Lumbar puncture performed. Three cubic centimetres of fluid withdrawn. The fluid, which ran out drop by drop, was not under pressure. It was slightly opalescent, but not yellow. A film of the cerebro-spinal fluid showed a small Gram-positive diplococcus similar to that found in the blood-film; the polymorphonuclear leucocytes in the film were not numerous. Culture subsequently showed the organism to be a pneumococcus.

The temperature rose in the afternoon to 103·8° F., but fell again in the evening to 100° F.

March 1: Patient stuporose. Breathing stertorous. Moderate rigidity

of the neck and limbs; athetoid twisting movements of the fingers. Pupils at times widely dilated, at others contracted. Conjunctival reflex just present.

Lumbar puncture repeated; ten cubic centimetres of fluid withdrawn. Fluid not under pressure and slightly blood-stained from striking a venous plexus. No pus-cells found in the fluid.

The temperature at 6 p.m. rose to 105° F., pulse 160, respirations 56. Death occurred at 10.20 p.m.

A partial post-mortem examination was performed on the following morning. The body was that of a well-nourished young male. The skin was free from hæmorrhages, etc.

Heart: Pericardium normal; heart not enlarged; weight, ten ounces; muscle normal except for an apparent increase of fat on the surface. Valves normal; the tricuspid orifice showed a slight degree of dilatation; the right ventricle contained a large ante-mortem clot.

Trachea: Showed signs of intense congestion.

Lungs: Left, signs of recent pleurisy at the base; weight, one pound twelve ounces; the lower lobe was very friable, and showed signs of hepatization, it tended to sink in water; the bronchi contained a purulent exudate. Right, no signs of pleurisy; weight, two pounds four ounces; the whole lung was congested, the lower lobe showing signs of moderate hepatization, but was not entirely devoid of air; sections of it floated in, but not on the surface of, water; the bronchi contained some purulent exudate.

Spleen: Smaller than normal; firm; weight, three ounces.

Liver: Appeared rather fatty on section.

Kidneys: Weight, four ounces each; no abnormality noted.

Brain: Congested; there was a moderate amount of yellowish-green pus along the sulci of the vertex and on the under surface of the cerebrum and cerebellum; ventricles normal; there was no free-lying pus over the vertex or at the base. A pure culture of pneumococci was obtained from the pus.

Remarks.—It is realized that the investigations into the case were not complete, e.g., a specimen of blood might have been cultured for pneumococci when diplococci were discovered in a stained blood-film. It must be taken into account, however, that the patient at the time was very ill, and that the finding of pneumococci in the cerebro-spinal fluid placed the diagnosis beyond doubt, for which reason blood-culture was not carried out.

It was also not possible to type the pneumococci. Interesting information might have been obtained from this, as about that time a number of fatal cases of pneumonia occurred at Rawalpindi, so that it may be assumed that the pneumococcus found was of a particularly virulent type (possibly Type III).

Observations.—The case described was one of pneumococcus septicæmia, with local lesions in the lungs and brain. The following features appear of special interest:—

(1) The finding of diplococci in a stained blood-film.

(2) The small size of the spleen.

(3) The absence of increased pressure in the cerebro-spinal fluid, even after the onset of definite meningeal symptoms, and also the absence in the fluid of definitely purulent matter, which was completely limited to the sulci on the vertex and base of the brain.

(4) By contrast with the cases of meningococcus septicæmia, the short duration and rapidly fatal course.

I am indebted for the bacteriological investigations to Major (now Lieutenant-Colonel) A. C. H. Gray, O.B.E., late D.A.D.P., Rawalpindi District.

A PLANT FLAGELLATE IN MAURITIUS.

By Major R. F. O'T DICKINSON, O.B.E.
Royal Army Medical Corps.

A paper by Richard P. Strong in the *American Journal of Tropical Medicine* for July, 1924, contained a description of a plant flagellate found in the latex of a species of Euphorbia, i.e., *Euphorbia pillulifera*, in Central and South America.

The author found that the parasites taken from the plant juice were not pathogenic to experimental animals.

As *E. pillulifera* abounds in Mauritius, I endeavoured to ascertain if any flagellates could be found in the plant, and if so whether experimental animals could be infected with them.

It is interesting to note that the first time a flagellate was described in plants was in Mauritius in 1909, by Lafont, and it was named by him *Leptomonas davidi*, after the laboratory attendant who actually first saw the parasite under the microscope.

An infected shrub was obtained, the milky juice of which contained considerable numbers of flagellates of the following description.

The body is long and tapering to posterior end. It varies from 10 to 15 microns in length, and from 1·5 to 3 microns in width. Macronucleus is large and centrally situated. The kinetoplast is small and spherical and stains very distinctly, and is situated near the anterior extremity of the parasite from which the flagellum comes off.

In some cases two thin parasites are seen lying side by side with their anterior ends fused, showing that cleavage has not quite been completed.

The parasite, therefore, corresponds with the one described by Strong, except that it is somewhat shorter and wider.

A saline emulsion of the milky juice was injected into guinea-pigs, mice and rats, but these animals were found to be quite unaffected by any pathological condition; smears from the blood, spleen, liver and marrow being negative for parasites.

Injections into lizards produced negative results. A monkey similarly injected showed no general or local pathological condition.

In the above-mentioned paper, Strong further found that a species of Coreidæ or land bug feeds on these shrubs, and is in turn preyed upon by small lizards, which in turn become infected.

A monkey inoculated by him with a portion of the contents of the large intestine of such lizards developed a lesion resembling an oriental sore, containing parasites resembling forms of Leishmania found in oriental sore.

No experiments could be done in connexion with these very interesting series of changes, owing to the difficulty of obtaining and identifying specimens of the Coreidæ in question.

My thanks are due to Dr. Tempany, Director of Agriculture in Mauritius, for identifying and supplying me with specimens of the infected plant, and to Corporal Riggs, R.A.M.C., for assistance with the experimental laboratory work.

Travel.

L'OISEAU ROUGE.

By U. P. A.

I.—The Frontier.

This is the tale of the tour of L'Oiseau Rouge.

It was a good car and groaned under an immense weight of things we didn't need and never used, though of course we couldn't do without them, and it's a pity they're so heavy, but—well we must just bring 'em along somehow.

It would be easy to write a long appendix showing the things you ought not to take with you on a motor tour. It wouldn't be worth while to make a list of the things you ought to take. Anybody could do that in a second—or just as long as it takes you to write the word "rupees."

Nabhi Baksh, *alias* Hop-o'-my-Thumb, or simply "the Hop," is a diminutive P.M. What there is of him is good. He spent part of his time looking after master and the other part looking for a wife. He was successful in the former occupation but, so far, has failed in the latter. I rather think he refuses to pay the inordinate sum demanded by the parents of his beloved. Well—it is *her* loss. Perhaps this matter will be adjusted satisfactorily in due course. Unfortunately there is no higher authority to whom it can be referred for final decision.

Georgina and I completed the party.

We started from Parachinar, N.W.F.P.

It is a good place to start from because, if the plugs refuse to spark or the carburettor chokes, you just give the 'bus a hearty heave and you're safe for the next fifty miles or so; it's all down-hill.

Parachinar is noted for the following :—

(*a*) Politicals. These gentlemen form an exclusive branch of the Heaven-Born.

They are sympathetic because they are recruited largely from the Army ; and altogether they are very nice people, except when they are criticizing each other. In this respect they bear a remarkable resemblance to the members of the medical profession.

(*b*) The favourite residence of the late Sir J. Roos Keppel, once Chief Commissioner, N.W.F.P. This beautiful two-storied house has a lawn in front, roses round the door, water hot and cold, and an office at the back.

The other day the Political Agent gave a decision for the plaintiff, Pathan A. The defendant, Pathan B, accepted the P.A.'s decision philosophically—until the parties to the judgment had cleared the office door, when he (Pathan B) cleft the skull of Pathan A in twain. 'Twas neatly done with a small hatchet ; no fuss or bother; just a little *swish !* and all was over.

(*c*) The Peiwar Kotal. The pass over which Bobs Bahadur made his first entry into Afghanistan. From Parachinar you can see the Afghan fort which crowns the pass.

A short time ago a couple of Citroën caterpillars managed to climb the rough track up the Peiwar. It was considered a good feat. Personally I'd prefer a few kajawah camels ; cheaper, safer, just as fast and—weight for weight—more efficient. Besides, a camel is never really sick or sorry. He plods on and on until the moment he decides to die, and then drops down and dies and that's all there is to it.

Again, have you ever compared the damage a camel may do with that which a caterpillar is capable of? I once saw a man whose shoulder was bitten off by a camel ; and another who had been run over by a tank.

Yes, the camel is easier and safer to manage.

(*d*) Sikka Ram. This fine peak is part of the Safed Koh range and fulfils two important functions.

(i) It provides a good line of retreat for the local outlaws.

(ii) It provides snow in summer for the Kurram Militia Officers'Mess.

The snowed soda-water of this Mess is the most popular beverage in the N.W.F.P. After 11.30 p.m. you are not compelled to ask for "a snowed soda-water" ; you may, with perfect propriety, use the less difficult symbol " a double S.W.," and you'll still get what you want. . . .

It is little amenities such as this which make life bearable, and even enjoyable, in the N.W.F.P.

L'Oiseau Rouge rolls down the steep declivity.

Georgina clutches and declutches her pocket pistol and practices aiming on the near-side head-lamp.

The Hop is bounced about on the baggage. Each time he hits the roof he says "Allah y Akhbar!" and thereby increases in sanctity. Sixty bumps and sixty steps nearer *Bhisti.*

First a stony plateau. Stones as big as footballs. Millions of them. Then a few stubbly fields. Then green and silver rice fields.

L'Oiseau Rouge rushes down a leafy lane. Leaves above. Leaves on each side. And if you know anything about trees you will see that these are chenars. A chenar has three uses only: to look beautiful, to give shade and to afford cover to the man with the gun.

Out of the lane and still downwards. On the left a bare hill-side. On the right a precipice with the Kurram River boiling far, far below.

On—on—ever on and on towards the mysterious East. On, ever on to the Taj By Moonlight and Mr. Gandhi's caps and Sweet William and Jullundur. Jullundur is where the Hop's beloved has her home, and the Hop has a dreamy look in his eye—in between bounces.

Presently the river bed widens below us, where the Kurram bends to the south on its way to Spinwam and Bannu.

On, and across a fine bridge, and we gain the shelter of the walls of Thall Fort, sixty miles from Parachinar.

Thall is the hottest place in the Kurram Valley. If you use a mosquito net the sandflies get you; if you use a sandfly net you become asphyxiated; and if you rely on fans the dynamo overheats and stops at 3 a.m., and if you soak in P.C. oil you lose your self-respect entirely. That beautiful poem (Indian version), beginning "O Night in June," must have been written in Thall.

Nevertheless, the traveller's heart is gladdened by the sight of Thall, for, no matter what unit may be in garrison there, hospitality is of the most catholic and generous description possible. Were I to found a Regius Professorship of Altruism, I would stipulate that the chair be placed in Thall.

Spinwam is in I.T. territory. A few years ago this village was giving us a lot of trouble, so a brigade was sent out from Thall, and Spinwam received a severe shock.

It was pitch dark before the brigade got back to Thall; and its line of retirement could be followed by marking the rifle flashes of the swarm of angry Spinwamites who blazed away almost to the wall of the fort. I watched this performance from the roof of the Officers' Mess.

No. This is not the story of the D.S.O. I deserved and didn't get. I'm leading up to quite another subject: the subject of the Colonel's lady in particular and N.W.F.P. ladies in general. The Colonel's lady was grey-haired and gentle. She, too, watched the progress of the rearguard action from the roof of the Mess. She didn't say anything, but perhaps she whispered a little prayer for the boys down below in the darkness. I think she did. Occasionally one hears it said—and often with reason—"This is no time and place for women." Nevertheless they are there at all times, and their presence is helpful and reassuring. If ever they do feel a little bit afraid—well, they never show it, bless 'em.

Having spent the customary thirty minutes more than we reckoned to

spend at Thall, L'Oiseau Rouge was steered out of the east gate of the fort and sped down the winding road past Roberts's Springs—a favourite place for the operations of the highwaymen from across the adjacent Border. These gentry are partial to regimental transport mules on exercise from the fort, to postal tongas, commissariat contractors' carts, etc., but they seldom tackle a motor car.

A certain A.D.M.S., on his way from Kohat to Thall, was stuck short of the Springs by an accident to his car.

It was dusk, and a gang of trans-Border outlaws was known to be lying-up in the vicinity.

Presently along the road came a party of five villainous-looking Pathans armed to the teeth. A.D.M.S. fingered his revolver and tried to guess which of the scoundrels would shoot first. However they turned out to be road-protection Khassadars.

They took A.D.M.S. to an open sangar near by. The mixture of ghi and garlic in the evening meal was too much for him, so he spent the night on a lively charpoy under the barbed wire apron. Early next morning he was rescued by an armoured car sent from Thall.

The sangar is still called Adam's Cabaret.

We are now clear of the Kurram Valley and in a district with the fine name of Miranzai. The Pathan names have a full-bodied, musical ring about them: Alizai, Samana, Miranshah, Orakzai. But you aren't following the course of L'Oiseau Rouge on a map; and unless you have been on the Frontier the tribal names will be meaningless.

The Pathans, like the Scots Highlanders, can combine against a common enemy, especially if the enemy is of another religion. Not only are they members of a church militant, they are fanatical members. But this combination is liable to break down on account of tribal (clan) jealousies and quarrels.

Then again, within the tribes there are often sectional bickerings; and within the sections family disturbances may still further weaken the body-corporate.

A Pathan is a manly and most independent individual, and these characteristics are also evident in the conduct and organization of families, sections and tribes. This intense individualism may even run counter to the decisions of their own jirgas or councils of elders.

The inner history of the Highland Jacobite clans at the close of the '45 reads strangely like an account of an episode in modern Pathan life. The constant quarrellings and the resultant blood-feuds are nearly always about religion, women, water or land. "A Life for a Life" is a law which no one dreams of questioning, and from which there is not the slightest chance of escape. It has been said that the blood-feud can never be extinguished until there is only *one* Pathan left alive in the world.

Incidentally—although a male life is of great account, a female life is comparatively cheap; cheaper than a good rifle, for instance. The Pathan's

treatment of his women is bad. The women do the work while he does the singing, dancing and shooting.

In addition to manliness and independence the Pathan possesses a keen sense of humour—a rare thing to find amongst any of the peoples of India. These qualities make him a favourite with the Sassenach at once—and at first. Before long we find he is incorrigibly lazy and uncommonly treacherous, and then we decide we can dispense with the sense of humour. It's more comfortable and infinitely safer to do so.

These remarks apply with special force to the Pathans of I.T. territory. In territory which is under British influence or rule a certain amount of "enlightenment" is to be found nowadays.

Now we are crossing a nullah—a cleft which holds a raging brown torrent whenever there is rain in the hills. At present it is bone dry, and up the bank on the opposite side stands the abandoned fortified camp of Darasamand. Somebody once suggested it should be made permanent, but his name is now on the retired list.

Away up on the left you can see the Samana Ridge, the razor-back which divides Miranzai from the I.T.T. of Tirah. The ridge is peopled by Orakzais who pass their lives pleasantly enough by selling milk, chickens and eggs to the garrison when they aren't hunting the garrison's scalps.

Three quaint little forts stand out against the sky-line on the very top of the ridge, at a height of 5,000 feet, and right on the Border: Forts Cavagnari and Lockhart, and Sangar Post.

The sight of them makes you feel thirty years younger; they are just like the toy castles of your Christmas lead-soldiering days.

A long bare slope leads up from the westernmost fort—Cavagnari—and from the edge of it you can look down on Dargai, where the Gordons and Gurkhas made their famous charge.

The Union Jack on Fort Cavagnari is nearly always in ribbons because of the perpetual breeze which blows on Gulistan. A native officer once told me that "Indent kya lekin Ordnance issue kubhi neh kya." I hope not; I prefer the breezy theory.

On the little eminence between this place and Fort Lockhart stands the sangar where the company of Sikhs was held up, fought and died to a man. The anniversary of this event is celebrated every year by the Sikh regiments in the Indian Army.

If you bang a ball over the north screen of the tennis court at Fort Lockhart, the ball goes into I.T.T., and has to be fielded by a trans-Border man.

Sometimes it isn't easy to sleep on account of strange noises under the walls of the fort at night. These reverberations, echoings, wailings and boomings are due to attacks of indigestion in the camel convoy lines.

The water supply is pumped up several hundreds of feet to the fort. When the engine breaks down the water is brought up in mule pakhals. On these occasions nobody gets a bath except by stealing somebody else's supply of drinking water.

We have now arrived at a more civilized place on the road, namely Hangu.

Careful driving is necessary in Hangu City (quite true, that's what it is called) to avoid running into dogs, children or deaf old men.

When the Sikhs ruled in these parts they appointed a Scots Governor to Hangu. I think—but I'm not quite sure—his name was Macdonald.

Outside this village there is a hillock still known as "Macdonald's (?) Seat." Here this worthy man must have sat in the cool of the evening watching the hills turn from blue to purple as the sun sank behind the mountains of Khost. Perhaps he idly turned the pages of the Khalsa Army List; he was nearing the critical age for promotion or H.P., or perhaps he just wondered if Macdonald Begum would be content with a new saxpence in place of the black silk Peshawari shawl he promised her last night.

The last stage of our first day's journey lies through a narrow, fertile valley, at the eastern end of which is Kohat, 120 miles from Parachinar.

Kohat is famous on account of the following :—

(*a*) The residence of the Deputy Commissioner. Built by Sir Louis Cavagnari. Spacious and well-furnished, with ample grounds, lawns, flower and vegetable gardens, group-incinerator (Lelean pattern) and bottle-khana.

The house possesses a fine central dome which might be used for high-flying trapeze exercise in the cold weather, and for facilitating the evaporation of perspiration in the summer months.

(*b*) The Piffers (the Punjab Frontier Force).

I apologize for dragging Scotland into this article for the third time; I hope it will be the last; but the Piffers are three-quarters Scotch and one-quarter proselytized Scots. They are very brave and efficient, difficult to bargain with, and most hospitable—if they like you. Their *esprit* is wonderful and their pipe-and-drum bands beggar description.

It is said that "All good Piffers return to Kohat to die." At the same time it is only fair to add that most people who have ever served in Kohat want to return there. It is not suggested that watching the Piffers die is one of the attractions of the place.

There is a Piffer Memorial Church in Kohat, one of the most beautiful and carefully-tended garrison churches to be found in all India.

(*c*) The Officers' Hostel. If you stay in this place your friends call it a hotel and your enemies call it a boarding house. You know it is neither. You know it is a glorified dâk bungalow.

Similar hostels exist in Peshawar, Lahore and other places. They are a great addition to the conversational amenities of cantonments.

Thus—when there is a dearth of bungalows, nobody wishes to go to the hostel. Conversely, when there are any number of vacant bungalows to be had, everybody wishes to live in the hostel.

As a result of this, the S.S.O. fully earns his extra-duty pay, and there is never a lack of something to talk about.

I still have a number of headings—to (x), (y), (z) in fact—but Kohat and the Kohatis deserve an article to themselves. Besides, it's time to push on to Peshawar. To linger longer than one night in Kohat will mean that Georgina's friends will find it easy to prevail on her to stay for a week, and the Hop's visions of ever reaching Jullundur may vanish altogether.

6 a.m. of the second day.

" Chhota haziri lata huzoor."

" Lao. Motor gharri achcha hai ? "

" Jee-hah."

" *Bon ! Nous nous en allons* jald-se," and The Hop grins, although his knowledge of French—Lilliers, 1914 brand—is becoming rusty.

Georgina collects the sandwiches and the thermos case. The Hop squeezes himself into a crater in the baggage mountain. The assembled multitude of menials prays, Mussulman fashion, for our long life and promotion to a peerage. L'Oiseau Rouge roars, growls and finally hums out of the north gate in the wire, heading for the Kohat Pass.

Here is a test : a cold, early morning engine, a heavy car, and four and a half miles of steep ascent over a narrow, winding road whose surface is anything but good. And then the checks : blind, hairpin corners, donkeys and camels and even huge, loose boulders fallen on the road. And no margin for error ; on the left a great jagged cliff often overhanging and, on the right, a sheer drop of hundreds of feet to the bottom of the cup below. A " hairy " spot certainly.

Allah be praised ! we manage the rise of 1,000 feet odd safely and without much trouble, and pull up under the walls of the little fort at the southern end of the pass.

The Hop looks round with a self-satisfied smirk. He is registering a vow that nothing on earth will ever induce *him* to look on Kohat again.

The folk who dwell cis-Indus don't love the Pathan or his country.

Georgina gazes down on Kohat, and away southwards towards Bannu, and droops. It is the end of four most happy years. They can never be relived. What does the future hold for us ? She says, sniffing audibly, " Do you think we shall ever see dear old Kohat again ? " I reply— " No." At least that's what I meant to reply ; but a beastly lump sticks in my throat and I have to drown the sound of swallowing it by jamming my foot on the self-starter pedal. Callousness, coupled with presence of mind, are great assets at times. In these respects a man scores.

L'Oiseau Rouge glides down into the lower part of the pass. The scenery is forbidding and much of it is still in shadow.

An offshoot to the left contains the Kohat hornets' nest : the home of badmashes who have been responsible for some of the most atrocious crimes in modern Frontier history.

The pass is inhabited by Afridis. They hold that they are not real Pathans. If that means that they are something worse then their claim must be accepted as proven.

From the fort at the southern extremity to the fort at the northern exit is a distance of fifteen miles, all in I.T. territory. The Kohat Pass Afridis are comparatively affluent, thanks to :—

(1) An income derived from the manufacture of "Pass Rifles." These weapons are fairly accurate at short ranges. They are sold to men who come from all over the Frontier.

(2) A subsidy paid by us in return for the guarantee of an open road. This accounts for the innumerable armed gentry who seem to have nothing to do and whom you meet dotted all along the road.

(3) Payment for road upkeep. This work is divided amongst the villages which stand on, or near, the road.

These modes of livelihood and subsistence result in jealousies and quarrels. For instance, if one village is given a contract for road repairs, and a neighbouring village claims two yards of the bit of road contracted for, a war ensues.

I have seen several such wars. The procedure is as follows :—

The men of Ali Shah's village keep up an intermittent fire on the men of Alum Beg's village across the way, who return the compliment. In the rear of each village a flag-wagging party occupies a point of vantage. When firing is in progress each f.w. party displays a white flag on a long pole. When firing is to cease the f.w.'s raise a red flag and wave it vigorously to attract the attention of all concerned. This is done when Mary drives the cattle home, on the approach of a sahib's motor car from Peshawar or Kohat, and on such-like important occasions. As soon as the cattle are safely home, or the car has passed through the war zone, the red flags are lowered, the white ones are raised, and firing recommences.

When Ali Shah's and Alum Beg's sharp-shooters are tired of target practice, when the crops have to be gathered, and on similar excuses, a truce is called for a week or a month or more; combatants fight their battles o'er again in jest and chaff across their boundary walls. But prompt to the minute of the expiry of the truce the war is renewed.

Some quarrels have been known to result in wars of this kind which have gone on for years and years. "India's Coral Strand" sounds so sunny and peaceful, but the picture has another side.

The fort at the northern exit stands at mile twenty from Kohat. Here one enters the Peshawar plain ; a dull place compared with the pass, but a respectable one.

Another twenty miles, with checks at deep nullahs, which are dry as dust one day and ten feet deep in raging torrents the next, and then we enter Peshawar. The baggage is off-loaded at Dean's Hotel and L'Oiseau Rouge is steered for the Khyber Pass.

The Khyber has a literature of its own. Books, reports, pamphlets and papers on the Khyber would fill a large-sized library. Hence I propose to leave it severely alone, except for three observations—observations which, curiously enough, have not yet been made on this remarkable and vital part of our Empire.

A lorry was coming towards us. A Pathan urchin was standing on the road embankment on our near side watching the lorry. He neither saw nor heard us. As we were passing the lorry the urchin sprang into the road; his head came into violent contact with our mud-guard. He was quite knocked out and lay as if dead.

I went up to him and spoke. He sprang up and ran off like a hare; that is, very fast and zig-zagging.

A road-protection khassadar hurried up and bade me not to be sorrowful. "Give me a rupee for this small son of Beelzebub and I will deliver it to him in due course. He is a stout lad, and one rupee will surely cure him at once," said he.

The Khyber had a caravan road. But camels are obstructionists, so somebody added a good road for wheeled transport. Somebody else wanted a third road, but, as the gorge was too narrow to hold it, he built an overhead rope railway instead. An Important Personage had his dignity upset by being shoved into a flour sack and dropped on a hard rock every two miles, so he had a fine broad-gauge railway bored through the hill-sides.

Brigade Commanders in the Khyber have the usual official designation; see the Indian Army List. But you might not think so, because you always hear them referred to in other terms: the King of the Khyber, the Jam of Jamrud, the Laird of Landi Kotal, and so forth.

The Khyber is Progressive but—it is also Conservative. The above picturesque survival of feudalism might well be copied by the "Brighter England" movement.

It is about thirty-five miles from Peshawar to the motor-halt. Here you look down on Landi Khana, our furthest outpost, and beyond is the Afghan Frontier with a magnificent range of snow-clad hills in the background.

There is a car on the road below; one can just see it with the glasses. The Hop finds a sheltered spot on the rocky spur and we settle down to tiffin.

Presently the east-bound car pulls up near us and a burly man steps out. He is wearing a bright green Homburg at the back of which an aggressive-looking feathery shaving brush sticks up in the air. Very carefully he places the Homburg on a flat stone. This reveals the fact that he has no occiput. Then he studies a book—obviously a guidebook—and consults the map. There is no one else like him: it is our old friend Fritz, of Flanders.

Have you ever read a German guide-book? It is solid. It is interminable. The compiler takes as long to describe a town of 500 inhabitants as an ordinary person would take to describe London and its suburbs. And what comes of it all? Indigestion.

I think my method is better; the Khyber, for instance. You all know about the Khyber now and, while increasing in knowledge, you have also been edified. For has the Khyber not taught us three distinct lessons—a lesson in charity, a lesson in progress, and a lesson in showing respect for the past?

What German guide-book does that? And, as our thoughts turn towards Peshawar, we ask if Peshawar too has something to teach us?

Yes, it has.

Peshawar makes a special appeal to us because it impresses us, firstly, with the mysteries and, secondly, with the powers of the science and art of medicine.

The newcomer to Peshawar is invariably attacked by a peculiar disease which, in its chronic form, is known as carpetbagging, and in its acute as carpetcraze.

Ætiology.—Infection is conveyed by box-walas, who work in pairs.

Each pair is accompanied by a coolie who carries a huge bundle of carpets and rugs.

Mass-infection may occur when the coolie is replaced by a two-wheeled hand-cart.

Symptoms.—The patient begins by buying a brick-red carpet covered with black octagonal patterns.

This is always the cheapest and most beautiful carpet in Peshawar.

The following week he purchases a cheaper (comparatively only) and still more beautiful carpet with a pattern unlike any other carpet in the world.

Progress.—The disease progresses as above until from ten to fifty carpets have been bought, each relatively cheaper and absolutely more beautiful than its predecessor.

The first carpet may have taken one hour to buy; the last will take a bargain time of $x \times y$, where x is the number of hours, and y the number of carpets previously bought.

Prognosis.—In a few favourable cases spontaneous cure takes place.

As a rule there is not even amelioration of the symptoms until the sufferer returns home to find that, in the London shops, the same carpets are offered for sale at much the same prices as in Peshawar.

This effects an instantaneous and permanent cure.

In the days of the Sikhs Peshawar was governed by an Italian soldier of fortune, General Avitabile.

Government House was then built on an eminence in the centre of the city, and stood up prominently for all to see.

Whenever trouble threatened, Avitabile hanged a few of the citizens from the walls of Government House *pour encourager les autres*; and when trouble did occur, he doubled the hangings and had a daily roster for suspension with a next-for-the-noose column.

This is the first authentic instance of the employment of the fear-complex in a scientific way.

People who write letters to editors on the subject, "Is Capital Punishment a Deterrent?" should study the records of Sikh rule in Peshawar. There was remarkably little crime and disorder in the city in those days.

Arrived at Dean's the speedometer registers 110 miles for the day's trip. Dean's is often an interesting hotel. Look at the visitors' book. There we find that the green Homburg hat is Herr Ludwig Schwalbacher, of the Elektrikfabrikengesellschaft, of Frankfort. He has been pushing electric hair-curlers in Kandahar.

Boris Rachmaninoff has passed through *en route* from Budapest to Jallalabad. He is a Roumanian aviator. What's he up to now? Mr. J. Jones's case is clearer. He is from Kabul for Bermondsey, having just delivered to the Amir a 12-cylinder gold-mounted Rolls-Renault saloon.

But here comes Ludwig with his infernal guide-book; let's off to bed!

(*To be continued*).

Reviews.

A SYNOPSIS OF THE FAMILIES AND GENERA OF NEMATODA. By H. A. Baylis, M.A., D.Sc., and R. Daubney, M.Sc., M.R.C.V.S London: Printed by order of the Trustees of the British Museum. Pp. xxxvi + 277. Price 10s. 6d.

This work, which is not illustrated, is a detailed classification of the class Nematoda, and includes both free-living and parasitic forms. As a book of reference it will be of the greatest service to the systematic helminthologist, and to those interested in the subject from an academic point of view. To those interested merely in human helminthology, it is hardly to be recommended, first because classification is not carried beyond genus, and second, because as human nematode parasites belong to a limited number of genera, a much simpler key can be evolved which is sufficient for all practical purposes.

In passing, one would remark that it is unfortunate that out of chaos there should have emerged in one year two works on approximately the same subject, the other being York and Maplestone's "The Nematode Parasites of Vertebrates," reviewed in this Journal, No. 3, Vol. XLVII, September 1926, in which, however, there is a different scheme of classification. In the work under review, the termination *-oidea* is given to *orders*. The usual convention is to reserve this termination for *superfamilies*, and its employment in another rôle may lead to some confusion. J. S. K. B.

PATHOLOGY, DIAGNOSIS AND TREATMENT OF FUNCTIONAL NERVOUS DISEASES. By Paul Bousfield, M.R.C.S., L.R.C.P. London: Wm. Heinneman. 1926. Pp. xi + 212. Price 6s.

This book on functional nervous diseases consists of three parts, the first part devoted to the energic foundations of psychology and the imagination in conscious and unconscious processes, and is simply put to give the reader with no knowledge of psychology an insight into this largely

unknown realm. Particularly useful is the author's conception of "tension" using this word in its broadest sense to include all forms of stress and strain, and applying it to states of psychological and physiological stress.

Only when our psychic tension reaches an unusual degree do we become aware of it consciously, though it may affect us and produce a functional disease without our knowledge.

The second part deals with methods of treatment in use and indicates with sufficient detail to be useful the essential methods of psychotherapeutic treatment, and the third part gives a comparatively detailed account of the common functional diseases, and classifies the diseases met with into the generally accepted headings of the psychoneurosis and the neurosis.

These are all necessarily included according to the nomenclature of diseases under the misleading term neurasthenia for the purpose of statistical records in the service.

It is still too commonly thought that the sufferer from a functional disease is merely a "neurotic" or suffers from an imaginary disease or is malingering.

To those with such a conviction Dr. Bousfield's book will show the importance of these diseases, their reality in that they exist as surely as an acute surgical condition, and can frequently be cured as easily by correct diagnosis and treatment.

Certain of the group of the psychoneuroses may without careful diagnosis and appropriate treatment be classified as a psychosis and treated as such by certification and treatment in a mental hospital, hence their importance from this aspect alone.

Apart from such a result the possession of a functional disease interferes gravely with the happiness and efficiency in life of the individual and the importance of dealing with the condition at the earliest possible moment is demonstrated throughout the book.

In conclusion, perhaps, an extract from the report of the recent Subcommittee of the National Council for Mental Hygiene may be quoted which indicates the importance with which psychotherapy is now being regarded.

"Such an analysis betrays only too clearly the utter inadequacy of arrangements as they now exist for the treatment of patients suffering from uncertified and uncertifiable mental disorders.

"Speaking of the huge majority of the population, it may truly be said that there are, indeed, no facilities for treatment worth speaking of, and that practically nothing is done to relieve the great suffering which is associated with mental disorder until such times as the patient becomes certifiable and is sent to a mental hospital—a result which could and would be avoided in many cases if it were not for the present apathy in dealing with the situation."

This extract is taken from the preface of the book which we feel will assist to clear away misconceptions regarding these diseases.

It will help those who are brought in contact with them—as indeed we all are—to adopt the appropriate treatment at an early stage.

The author has a broad outlook on his subject and expresses his views in clear, straightforward language. We commend this readable little book to those who are interested in the problem of functional nervous disease.

W. L. W.

RADIOGRAPHY IN RELATION TO GENERAL MEDICINE. By F. Hernaman-Johnson, M.D.Aberd. Oxford Medical Publications. Oxford Medical Handbooks. London: H. Milford, Oxford University Press. 1926. Foolscap 8vo, pp. ix + 211. Price 5s. net.

This book, like many others recently published on sections of medical radiology and therapy, is not a textbook but a very excellent general survey of the fundamental principles which underlie the special subject, together with a reasoned consideration of the scope, limitations and respective values of radiotherapy in a large variety of conditions. The author is to be congratulated on his own experience and results, and especially in that he has not blindly followed old methods but has struck out on any new line of progress that presented itself as a possible solution of the many grave difficulties that constantly block one in furthering a subject such as this.

Success is bound to come when the broad view is entertained and every channel of investigation is so closely followed.

The book should be read not only by all interested in radiotherapy but also by all up-to-date medical men who have not had the time to labour through big textbooks.

AN INTRODUCTION TO THE STUDY OF X-RAYS AND RADIUM. By Hector A. Colwell and Cecil P. G. Wakley. Oxford University Press: Humphrey Milford. Pp. 203, 35 illustrations and numerous data and tables. Price 10s. 6d.

This book professes to be of a purely introductory nature and although this is partly true, it contains so many useful facts, data and details of the author's experiments that no radiographer or radiologist should be without this information. Many of the facts are mentioned in other textbooks, but nowhere so clearly marshalled. The book, of course, does not pretend to be a textbook on these subjects, it could not do so in 203 pages, but the fundamental and essential facts of radio-activity and X-rays are put forward with great precision and clearness, and perusal will save much time in wading through the first 200 pages of most textbooks.

The book ought to be read and kept at hand by all radiographers and radiologists.

It is very pleasing to see it dedicated to such a distinguished master of physics and radiological research as Professor S. Russ, D.Sc.

A HANDBOOK OF MEDICAL ELECTRICITY AND RADIOLOGY. By J. R. Riddell, L.R.C.P.&S.Edin., F.R.F.P.&S.Glas., Medical Electrician, Western Infirmary, Glasgow; Lecturer in Radiology and Electrical Therapeutics, University of Glasgow. Edinburgh: E. and S. Livingstone. 1926. Crown 8vo, pp. 240, 110 illustrations. Price 8s. 6d. net. Inland postage 6d.

This small handbook is written for the student and includes a short general summary of electrology, X-ray physics, radiotherapy, radium, actinotherapy and radiology. Little or no information is given regarding technique or radiography. The short account of these subjects is useful in giving a student a basic idea of the scope of the electrical medical modalities but does not quite clearly show the limitations of these subjects. Small books such as this fulfil a definite function, but are not of great value to the Services as they do not quite cover the ground required for our needs. For example, the short chapter on localization is not very helpful to a student, as the only method I find useful in teaching, namely, the explanation of the original Mackenzie Davidson cross threads, is omitted.

Triangulation to the not too mathematical student needs very careful visualization before the principles and the actual threads can be discarded for formulæ.

It is noticed with regret that the author has not adopted a definite nomenclature, such terms as X-ray picture rather clash with present ideas. However, for those who must have a general idea of these subjects and thus prepare for general examination this handy volume covers the ground shortly, concisely and cheaply.

THE RED CROSS: THE IDEA AND ITS DEVELOPMENT. By Colonel Sir James Magill, K.C.B., M.A., M.D. London: Cassell and Co., Ltd. 1926. Pp. 144. Price 5s.

This little volume on the Red Cross has been written with a view to interesting the members of the British Red Cross Society, of which the author was for many years the Organizing Secretary, in its history and work. It sketches briefly the well-known origin of the Red Cross idea from the publication of Dunant's "Souvenir de Solférino" until the time when a British Red Cross Society became an organized body after the South African War. Before that time there had existed since the Franco-German War a National Society for Aid to Sick and Wounded in War, but it had no peace organization, such as had the National Red Cross Societies of the Continental powers. It was only after the report of the War Office delegate (Major W. G. Macpherson) to the International Red Cross Conference in Vienna in 1897 that peace organization of voluntary aid was taken in hand, and led to the formation at the War Office of a Central British Red Cross Committee in 1898. Out of this the British Red Cross Society was evolved and came into being in 1905. Its later developments are described and

especially the formation of Voluntary Aid Detachments at the instigation of the War Office in order to fill gaps in the organization of the medical services of the Territorial Force. They are of more recent date; but it is interesting to note now that the Central Joint Voluntary Aid Detachment Council, instituted some four years ago and composed of representatives of the Admiralty, War Office, Air Ministry, Territorial Army Associations, the British Red Cross Society and the St. John and St. Andrew's Ambulance Association, comes back to the idea in the minds of those who set up the Central British Red Cross Committee in 1898. There are many historical points of interest in the development of the Red Cross idea in Great Britain but Sir James Magill scarcely touches on these, and could not very well do so in a brief sketch. He has given his readers, however, a just appreciation of the efforts made by the British Red Cross Society in the Great War and in the smaller wars, from the time when its precursor, the National Aid Society, was instituted in 1870. There is a considerable literature on the subject of the Red Cross idea, and if in any future edition Sir James Magill could introduce a bibliography of British and foreign writings on the subject, we feel sure it would add to the value of his book and enable readers, who are so inclined, to go deeper into the subject than this interesting little volume permits.

X-RAY DIAGNOSIS. By J. Magnus Redding, F.R.C.S., Senior Surgical Radiologist to Guy's Hospital. London: Cassell and Co., Ltd. 1926. Pp. 228 with 80 reproductions of radiograms. Price 21s.

We congratulate Mr. Redding on this book, and especially on his concise introduction, which very aptly sums up the more important points in the "Diagnosis"; very noticeable is his teaching that the radiologist should add to his radio-diagnosis an estimate of the exact value to be attached to each individual examination, as he alone understands the difficulties appertaining to certain examinations.

The one certainty in radiology is that a spot diagnosis will be wrong, and only a careful summing up of all the points, fluoroscopic, radiographic and in some cases clinical, will enable a correct interpretation to be made.

In the bone section a very comprehensive selection of cases is given, but some of the illustrations have lost clearness in reproduction; this is unavoidable and the inexperienced interpreter should note that attention should be confined to the original film and not to prints therefrom. The author's views on the frequency of failure of the fusion of the lumbar arch of the fifth lumbar vertebra, and the lack of any special significance attaching to this, is interesting as it coincides with our experience and discountenances the many symptoms recently attributed to this condition.

Mr. Redding is a great authority on abnormalities, and apparently has the happy knack of recording them all as he came across them; although most are well known to radiologists, it is a pleasure to see them so carefully classified and so methodically summarized.

In the alimentary section a very complete survey of technique is given, but it should be noted that in this system the deductions from, and the times and frequency of abdominal examinations, will only give satisfactory results when a routine technique is employed in any one laboratory. The importance of this is that for radiological diagnosis to have any weight, a constant record must be made of the accurately timed radiological appearances, the deductions therefrom, and in surgical cases of the appearances on the operating table.

It is with regret that we notice such lapses of terminology as "skiagraphic plates."

The volume is a compilation not only to be read, but to be studied slowly; it is a mine of information.

The reproductions on the whole are good, the paper might be better, and the price is negligible for so good a work.

To make this volume more complete Mr. Redding might have added a chapter on "Localization," as this really comes under the heading of X-ray diagnosis.

D. B. McG.

Correspondence.

NOTES ON MEDICAL SERVICES IN THE FIELD.

TO THE EDITOR OF "THE JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

SIR,—The article of Lieutenant-Colonel T. S. Dudding, O.B.E., in the March and April issue of the ROYAL ARMY MEDICAL CORPS JOURNAL is most interesting and has entailed a lot of time and thought on the part of the author.

The question of the detail of medical tactics is one of more or less individual opinion and no medical scheme or order can be said to be wrong provided it is based on sound principles and correct deductions, and a clear statement and concise instructions are written in the shape of either administrative instructions or actual R.A.M.C. operation orders in the form prescribed in Field Service Regulations, Vol. I, Chapter XIV. But there is one sentence with which I must at once join issue and attempt to correct lest it bear fruit detrimental to the medical service, interfere with the proper and efficient collection of wounded and lower the prestige of the Corps not only in our own eyes but in the eyes of the Army at large, showing a willingness to take anything rather than insist on that which we are justly entitled to. If we accept the principles set forth, and take them lying down, other things will follow, and we shall always be expected to MAKE DO.

On page 260 of the April number we find the following: "The A.D.M.S. usually details a motor ambulance car, a motor cyclist and orderlies from a field ambulance for his own use, to render himself and the D.A.D.M.S. independent of the divisional arrangements which are rarely sufficient to meet his requirements."

I do not cavil at the orderlies or the motor cyclist, though a cyclist can be got from Signals as required and especially for urgent messages, but I do cavil greatly at the ambulance car. This is a medical technical car, and its duty is to carry sick and wounded. The A.D.M.S. has a right to share in the divisional pool of cars. If the A.D.M.S. once starts to use an ambulance car, the Divisional Staff will see that he is doing so, and will then insist on his using it always, and never give him an allotment from the staff cars.

If the principle that the A.D.M.S. is to use a motor ambulance car for carrying out his legitimate duties be correct, then it is equally right for the C.R.A. to be expected to withdraw a "Dragon" from one of the batteries in the field artillery brigades under his command, for O.C. Divisional Train and Divisional M.T. Company to use a light lorry or light van, for the C.R.E. to withdraw one of his technical M.T. vehicles, and for these officers to use these technical vehicles to enable them to carry out their duties, and even for "Q" of the Division itself to call on a lorry or light van from the M.T. company for his purposes: in fact, to give only one touring or staff car to a Division, and that for the G.O.C.

Can you see the C.R.A., C.R.E., O.C. R.A.S.C. or "Q" doing as I suggest? Most certainly not. A cry would be made by the staff and the units concerned that would be heard to the end of the world.

No. An A.D.M.S. should never use an ambulance car for the purpose suggested. He should insist on his right to the use of a staff car to carry out his duties, and refuse to be responsible for the efficiency of his medical service if his request is refused.

When I went as A.D.M.S. to a division in France, I found that I was expected to use an ambulance car five times out of six; on the sixth I got a car. I saw my General and explained matters, and told him I would not hold myself responsible for the efficiency of the medical duties of the division if I did not get my car, and that I would sooner apply for another job than work under the condition of a constant answer from the Staff of "No car available for A.D.M.S.; use an ambulance."

I got my car and had it all the time I was with the division. It was detailed to me, and if "Q" wanted it or wished me to take other officers out when I was going in the direction that they wished to go, they had to ask me for it.

The White Bungalow,
Tidworth.
April 23, 1927.

I, am, etc.,
LANGFORD LLOYD,
Colonel.

Notice.

THE WELLCOME HISTORICAL MEDICAL MUSEUM DESCRIPTIVE CATALOGUES. THE WELLCOME FOUNDATION, LTD.

WE have received two volumes commemorative of the reopening of the Wellcome Historical Museum at 54A, Wigmore Street in October last year, and of the Lister Centenary in April last. The first of these contains a descriptive catalogue of the Museum and reprints of the addresses at the opening ceremony in 1913 and the re-opening ceremony in 1926. The other volume is a souvenir handbook prepared for the exhibition held at the Museum in connexion with the Lister Centenary celebrations. It contains a short account of the evolution of antiseptic surgery, by Sir Hector Cameron, a life of Lord Lister, together with an account of his pioneer work, experimental researches, original surgical work, his associates and his honours. The addresses at the opening and reopening ceremonies are also added to this volume. Both volumes, especially the Lister centenary volume, have excellent illustrations, including photographs of Lord Lister and his associates in the latter volume.

The museum, it may be noted, was opened as the official museum of the Section of the History of Medicine at the Seventeenth International Congress of Medicine in London in 1913, by Sir Norman Moore; and was reopened after complete reorganization last year by Sir Humphry Rolleston. Those who have not visited it should take an early opportunity of doing so. It is a wonderful collection of extreme interest and importance, admirably arranged. Some beautiful examples of prehistoric and Greek, Roman and Egyptian medical and dental appliances are to be seen in it, in addition to many examples of fetish worship, medicine men, and everything connected with the practice of medicine surgery, pharmacy and alchemy in mediæval times and later years. There is also an excellent War Section exhibition with large models of the famous dressing stations at Harley Street, Contalmaison and Vimy Ridge in the Great War. In fact the Wellcome Historical Medical Museum may aptly be described as unique of its kind, and readers of the Journal should not fail to pay it a visit.

INDEX TO VOLUME XLVIII.

C.N. = Clinical and other Notes.
C.L. = Current Literature.